The Blast Furnace and Steel Plant

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Vol. X PITTSBURGH, PA., SEPTEMBER, 1922 No. 9

Association of Iron and Steel Engineers Annual Convention

The Sixteenth Annual Convention and the Fourth Annual Exposition of This Society Will Be Held in the Cleveland Public Hall, September 11 to 15.

THE Association of Iron and Steel Electrical Engineers will hold their annual exposition and convention at Cleveland, Ohio, September 11 to September 15, the official headquarters being the Statler Hotel, while the convention sessions will be held in the Cleveland Public Hall.

It is expected that a very large crowd of steel mill officials, such as general managers, general superintendents, department superintendents and engineers will be in attendance.

Aside from the technical sessions, the exposition offers an opportunity for these officials to become better acquainted with the latest advances in the electrical and mechanical arts. Practically all the manufacturers of electrical apparatus will have booths and demonstrate their appliances at the exposition.

The technical program, as arranged, is exceptional, as a glance at the list of subjects to be presented will readily prove:

"Improvement in Efficiency of Electric Power Supply."

"A Review of Steel Mill Electrification."

"Boiler Practices of 1922."

"Education" and "Safety."

"The Gas Engine as a Prime Mover for Power Generation."

"Steam Turbines."

"Judging Combustion From Gas Analysis."

"Electrification of the International Nickel Company's Works for Monel Metal."

"Some Considerations in the Electrification of the Steel Plant Railroad Yard."

"Power in the Iron and Steel Industry."

"Control-Motor-Lighting and Crane Standardization."

"Electric Furnaces."

"Electrical Developments in 1922."

"Investigation of Insulators for Steel Mill Service."

These papers have been prepared by the foremost engineers of the electrical industry, including such prominent persons as:

Dr. C. P. Steinmetz, B. G. Lamme, Wilfred Sykes, D. M. Petty and others.

It may be of interest to know something about how the Association of Iron and Steel Electrical Engineers originated and some of the history of the society since its inception.

Sixteen years ago, at a dinner attended by electrical engineers and electrical superintendents of the steel industry, one of the superintendents abruptly conceived the idea of perpetuating dinners of this nature, at which time discussions relative to the application of electricity to the steel industry would be presented, and, through the interchange of ideas of practical operation, a broader viewpoint of electrical application would be obtained, thus enabling the engineers and superintendents to obtain the advantage of each other's experiences in field operation.

The papers to be presented at the Association of Iron and Steel Electrical Engineers' convention, Cleveland, September 11 to 15, have been abstracted and will be found in the special section devoted to this convention, further back in this magazine. A directory to the booths, including the names of the various companies' representatives, will also be found there.

The suggestion provoked considerable discussion, and thus was brought about the formation of the Association of Iron and Steel Electrical Engineers.

This association has functioned regularly since that time, starting firstly with annual meetings, then sectional meetings being held in Pittsburgh, then sections were formed at Chicago, Cleveland, Philadelphia and Birmingham.

From the inception, this society devoted some of its time to the question of safety in steel mills. This question developed such proportions that it was thought best to form a separate organization to handle this mat-

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ter in its entirety. From this came the formation, under the auspices of this association, what is known as the National Safety Council, of which we are justly proud. This accomplishment is particularly gratifying and has always been an inspiration towards the accomplishment of some of the big questions which have been brought up and solved since that time.

For fifteen years annual proceedings have been issued which contain the papers presented by steel mill engineers before this association. These proceedings are used internationally as references, especially so when new installations are contemplated; also for the performances of electrical apparatus installed in steel mills.

American electrical steel mill practices are being appreciated more and more in the foreign countries as each year the demand for literature from this association is increasing enormously, so much so that there are possibilities of the formation of a permanent section in some part of Europe.

In this country, some of the leading engineers in steel mills have written their expressions of appreciation for the valuable information contained in our issues, and it is a frequent request that some of these engineers have in asking for complete sets of these volumes.

It has been remarked at times that this organization tends to become narrow in confining its activities to one branch, that of the iron and steel industry.

Considerable deliberations were had on the subject of broadening these activities, but it was felt that in order to be of any value to its members, it had considerable to do to handle efficiently this one branch, in view of the fact that were time devoted to other branches, little would be accomplished in the way of furthering its original aims, that of the electrification of the iron and steel industry.

It was felt, however, that in order to completely cover the subject of electrification it would be necessary to enlist the support of the combustion and steam engineers of this industry.

From this idea was formed the Combustion Engineering Section of the society. While it has been organized only two years, its success was evident from the start.

Year after year questions concerning the industry are brought up, discussed and solved, which ultimately tends towards greater production at lower cost.

Likewise, conventions each year are attracting more and more attention, and the good accomplished at these annual meetings is evidenced by the increased number present at the sessions and exhibits and the number of engineers participating in the discussions of the various subjects presented.

Some of the leading scientists and engineers in America, as well as Europe, have taken an active interest in the convention being held this year, among them being Dr. C. P. Steinmetz and B. G. Lamme, in this country, and Sir Robert Hadfield of England.

The convention this year is attracting considerable interest and arousing enthusiasm to such an extent that the "Iron and Steel Exposition" this year will be one long to be remembered.

THE DISCOVERY OF MANGANESE STEEL

Hadfield's discovery of manganese steels as a result of research practically started the study of alloy steels. Before him, Mushet had, indeed, worked out empirically a self-hardening steel for metal-cutting tools, but it gave no such impetus to research in the field of useful metals. As a young man Hadfield started experimenting in his father's steel foundry to see if he could find a hard steel suitable for tram-car wheels. He melted his mixtures in crucibles and tested his products by the means then at hand—the file, chisel, forge, magnet, and hardening and tempering. These were enough to enable him when he first made an alloy coming within the definition of manganese steel to realize that he was dealing with a new metal.

Before his time, everyone who had tried the effect of increasing manganese in steel had found that the steel was made harder and less ductile with each increase, so that if 2.5 per cent were present the product was too hard and brittle to be of any use. The highest proportion ever added had been 3.5 per cent, which made the steel even more brittle. Naturally it was believed that more manganese would merely result in still greater weakness.

Hadfield, however, took nothing for granted, but tried everything and as a result found the new alloy which, when it contained about 13 per cent manganese, and was properly heat treated, had maximum combined properties of strength and toughness. He told his father, Robert Hadfield, and his superintendent, Mr. Mallaband, about his discovery. They were naturally skeptical and told him that he would better repeat his experiments. He did so with the same result and then they began to take notice.

Here was a high-carbon steel which in several ways was the opposite of what would be expected by any one familiar with iron. A magnet would not attract it, and when heated to a bright orange heat and cooled quickly, as by immersion in cold water, it was given extraordinary ductility. There were other less notable features, but these were enough to excite astonishment.

Naturally, the first attempts to adapt the new hard metal were for cutting purposes, particularly for metals, ,but experiments in that direction came to naught. The great field for this steel, resistance to abrasion, particularly by earthly materials such as rocks and ores, was not fairly recognized until ten years after the steel was first made.

The discovery, as the result of systematic research, of a metal having such unique properties as manganese steel, started other steel makers to see whether additional useful alloys could be found. As a result of these activities, which eventually extended throughout the civilized world, many alloy steels have been developed of exceeding importance, which have advanced materially the useful arts and particularly the conquest of distance on land, in the air and under the sea.

This discovery also argues strongly for research even without a definite object. Hadfield was searching for a hard steel for another purpose. He had no idea of finding a non-magnetic or water-toughening steel. So anyone has a chance of finding something new and useful in any systematic investigation or research which explores any unknown field of knowledge.

*Contributed by Henry D. Hibbard, consulting engineer, Plainfield, N. J., to "Engineering Foundation."

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Heat Balances of Blast Furnace and Steel Plants

Interesting Charts Showing Heat Balances for an Uneconomical Steel Plant, an Average Steel Plant, an Economical Steam Operated Steel Plant and an Ideally Operated Steel Plant Are Given.

By W. TRINKS

IN the production of iron and steel, fuel is only one item of expense, but it is by no means an inconsiderable one, although, in the United States, it is not nearly as large as the item of labor cost. The old saying, "The coal never goes to the iron ore, but the iron ore always goes to the coal," emphasizes the importance of fuel in the iron and steel industry. This old saying is no longer correct, because fuel economies in the production of iron and steel have brought the relative fuel consumption down to such an extent that a steel plant can now be located with justification anywhere between the iron ore mines and the coal mines.

In European steel plants, fuel economy has played a much bigger part than it has in American plants, and rightfully so, because on the European continent a ton of coal is worth as much as the daily wage of six labor-

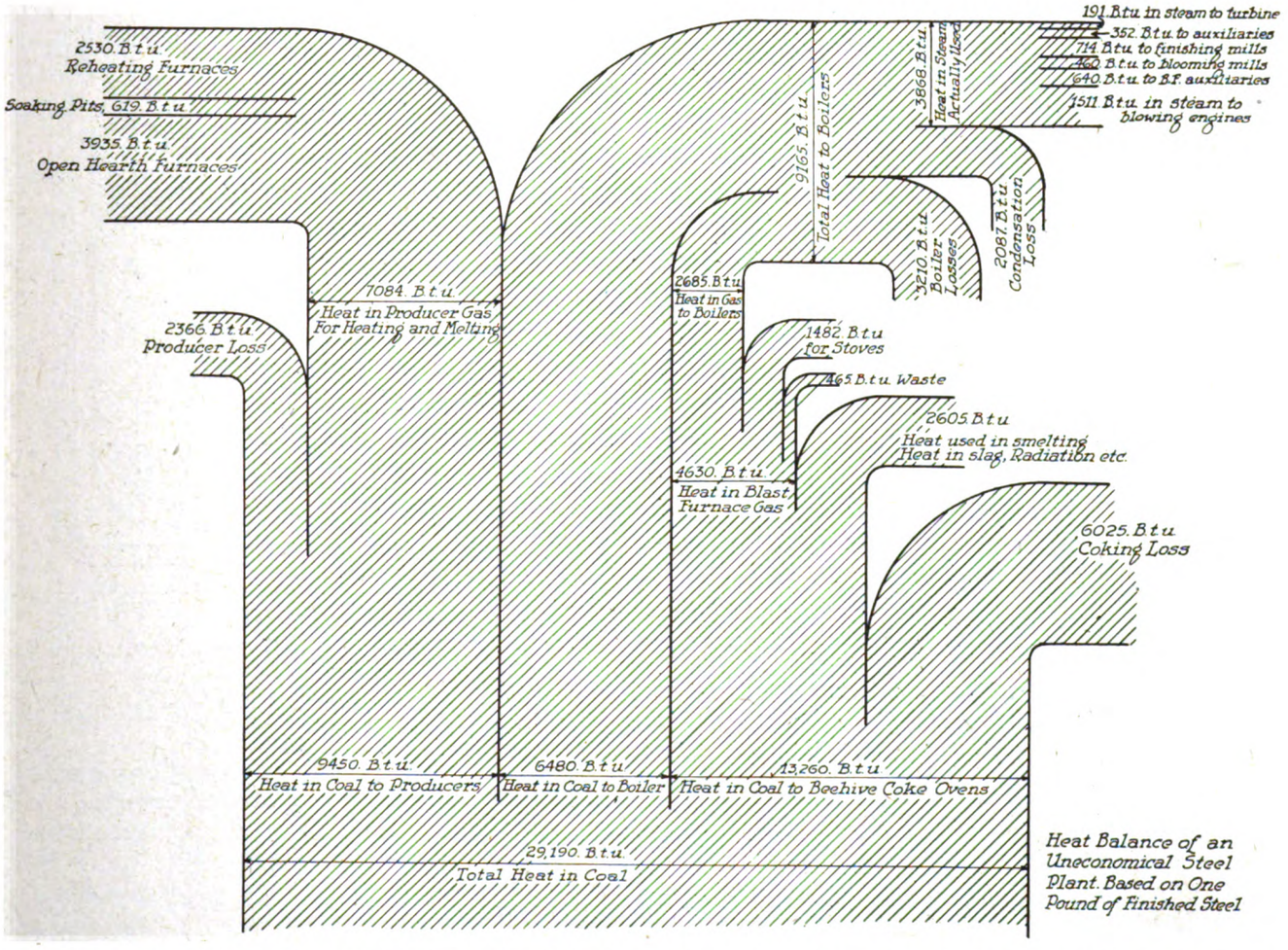

Fig. 1—Heat balance of an uneconomical steel plant based on one pound of finished steel. This heat balance is based on 50 per cent scrap, 50 per cent cold pig iron being used in open hearth furnaces. One-half of the product rolled to 1-in. squares, one-half to 8-in. beams. 1.13 lbs. of blooms required per lb. of finished steel; 1.26 lbs. of ingots; 0.675 lbs. of pig iron plus 0.675 lbs. of scrap per lb. of finished product. 2200 lbs. of coke used in blast furnaces per long ton of pig iron produced. 7,000,000 Btu. required in open hearth per long ton of ingots produced; 1,100,000 Btu. in soaking pits per ton of ingots; 4,500,000 Btu. in reheating furnaces per ton of blooms or billets. Mills driven by steam engines, 150 lbs. saturated steam, non-condensing. All auxiliaries steam operated. Steam blowing engines, non-condensing. Beehive coke ovens. (Note: All figures represent Btu. per lb. of finished steel.)

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ers, whereas in the United States it is worth the daily wage of one laborer. If, to save a ton of coal per day, we must put on an extra laborer, we have saved nothing, as far as the final cost of steel is concerned; on the other hand, an European plant would, by the same process, save five-sixths of the cost of a ton of coal per day.

If we keep these facts in mind, we need not wonder at the different views which European and American steel works managers take of heat economy and of heat balances. The European manager studies the heat balance carefully, trying to find ways and means for saving a few more heat units. The American manager is apt to ask: What good is the heat balance after you have it? However, that happy frame of mind of the American steel plant manager cannot exist forever, partly because coal prices are rising steadily and partly because consideration of national resources demands better fuel economy.

From the standpoint of the desirability of fuel saving, it is unfortunate that its realization requires the in-

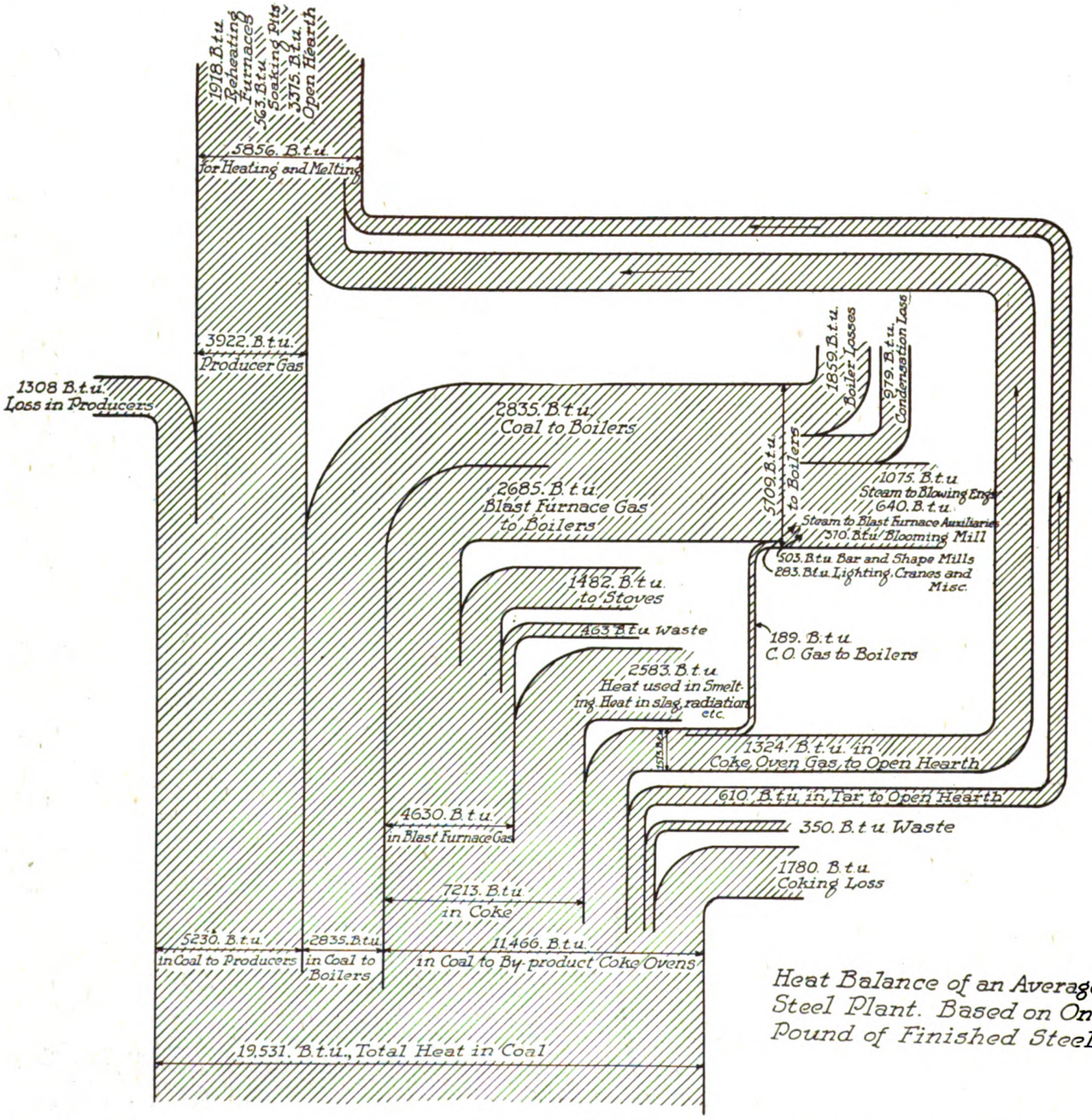

Fig. 2—Heat balance of an average steel plant. Based on one lb. of finished steel. This heat balance is based on 50 per cent scrap, 50 per cent cold pig iron being used in open hearth furnaces. One-half of the product rolled to 1-in. squares, one-half to 8-in. beams. 1.13 lbs. of blooms required per lb. of finished steel; 1.26 lbs. of ingots; 0.675 lbs. of pig iron plus 0.675 lbs. of scrap per lb. of finished product. 2200 lbs. of coke used in blast furnaces per long ton of pig iron produced. 6,000,000 Btu. required in open hearth per long ton of ingots produced; 1,000,000 Btu. in soaking pits per ton of ingots; 3,800,000 Btu. in reheating furnaces per ton of blooms or billets. Mills driven by steam engines, 150 lbs. saturated steam, 20 in. vacuum. Blast furnace auxiliaries steam operated, all other auxiliaries electrically operated. Electric power supplied by turbo-generator, steam blowing engines and turbo-blowers, 150 lbs. saturated steam, 20-in. vacuum. (Note: All figures represent Btu. per lb. of finished steel.)

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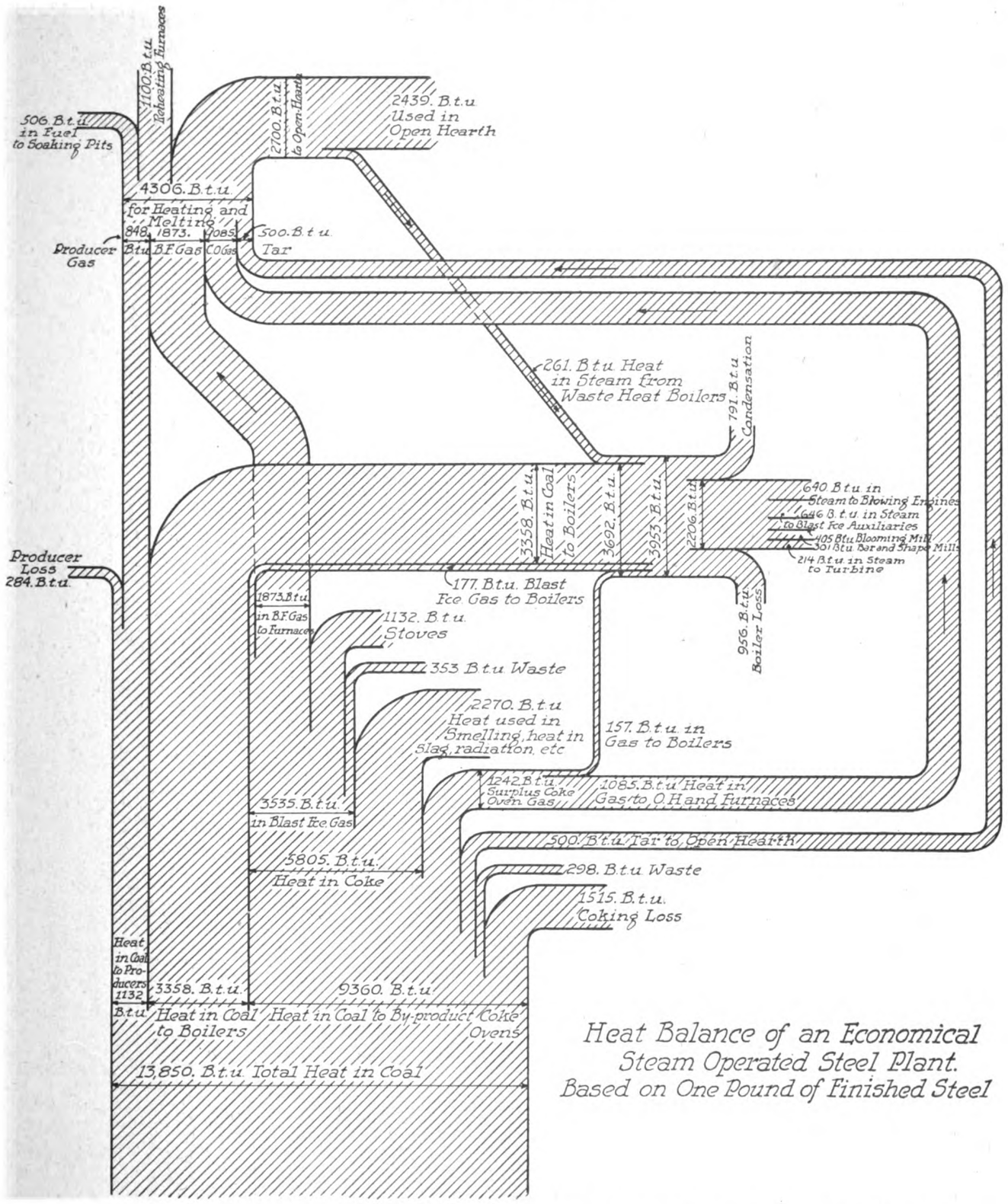

Fig. 3—Heat balance of an economical steam operated steel plant. Based on one lb. of finished steel. This heat balance is based on 50 per cent scrap, 50 per cent hot pig iron being used in open hearth furnaces. One-half of the product is rolled to 1-in. squares, one-half to 8-in. beams. 1.13 pounds of blooms required per lb. of finished product; 1.26 lbs. of ingots; 0.675 lbs. of pig iron plus 0.675 lbs. of scrap per pound of finished product. 1,800 lbs. of coke used in blast furnaces per long ton of pig iron produced. 4,800,000 Btu. required in open hearth per long ton of ingots produced. 900,000 Btu. for soaking pits per ton of ingots; 2,750,000 Btu. for reheating furnaces per long ton of blooms or billets. A mixture of coke oven gas, blast furnace gas, and producer gas is used in reheating furnaces and in pits. Mills driven by economical steam engines, operating with steam at 200 lbs. pressure, 100 deg. superheat, 27-in. vacuum. Blowing engines steam driven, same conditions as above. Blast furnace auxiliaries steam operated, other auxiliaries electrically operated. Electric power supplied by turbo-generators, 200 lbs. steam pressure, 100 deg. superheat, 28-in. vacuum. (Note: All figures represent Btu. per lb. of finished steel.)

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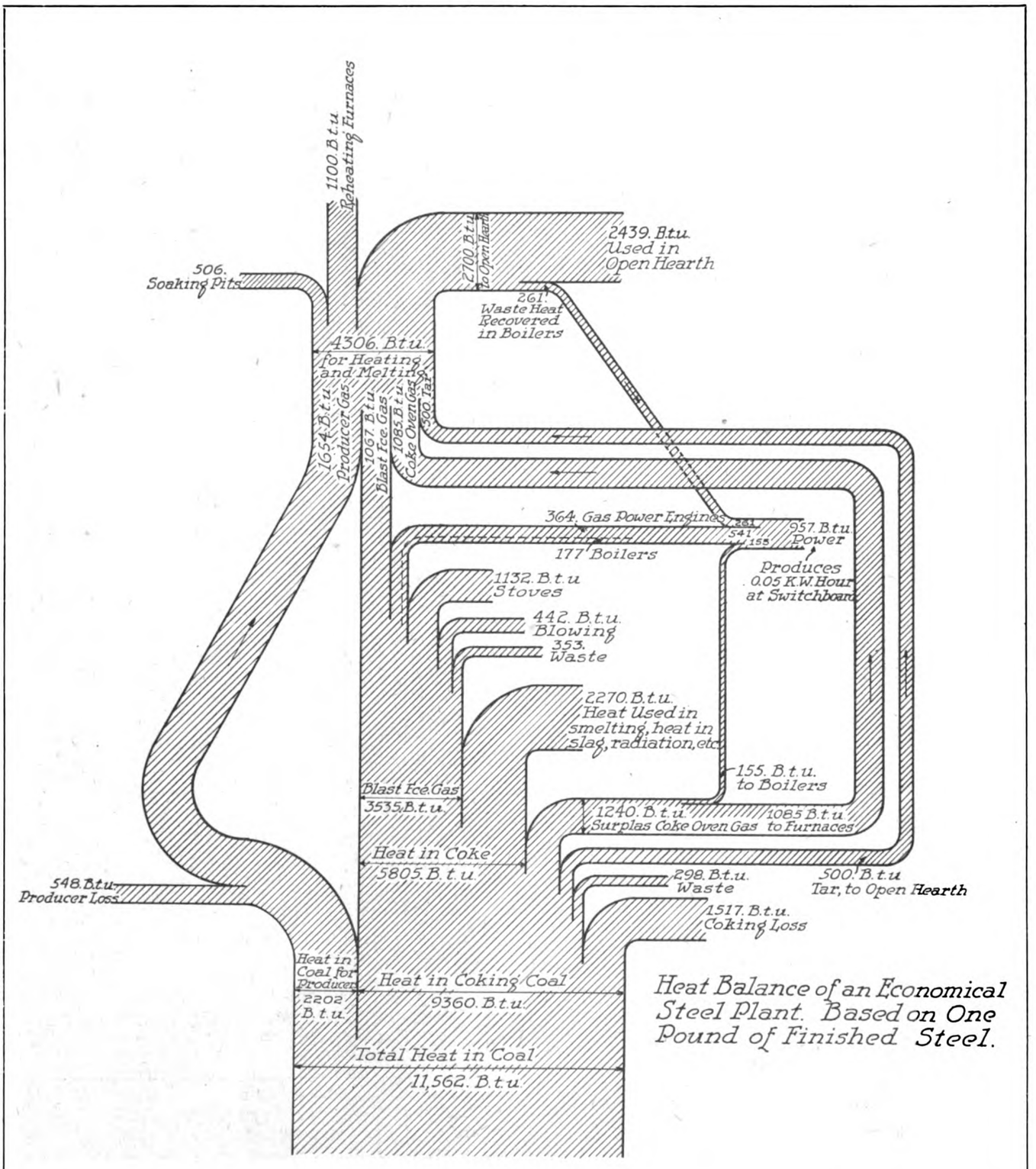

Fig. 4—Heat balance of an economical steam plant. Based on one lb. of finished steel. The heat balance is based on 50 per cent scrap, 50 per cent hot pig iron being used in open hearth furnaces. One-half of the product rolled to 1-in. squares, one-half to 8-in. beams. 1.13 lbs. of blooms required per lb. of finished product; 1.26 lbs. of ingots; 0.675 lbs. of pig iron plus 0.675 lbs. of scrap per lb. of finished product. 1800 lbs. of coke used in blast furnaces per long ton of pig iron produced. 4,800,000 Btu. required in open hearth per long ton of ingots produced; 900,000 Btu. for soaking pits per ton of ingots; 2,750,000 Btu. for reheating furnaces per long ton of blooms or billets. A mixture of coke oven gas and blast furnace gas is used for reheating furnaces and in pits. Power consumption includes blast furnace auxiliaries, rolling, cranes, lighting, shears, tables, etc. (Note: All figures represent Btu. per lb. of finished steel.)

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vestment of considerable capital for fuel saving equipment. In the investigation of the problem, to what extent the installation of such equipment pays, several steps are required, namely, the determination of (1) how much can be saved, (2) what equipment is necessary for that purpose, and (3) what is the cost of that equipment? For a clear view of the relations affecting items (1) and (2), nothing is as helpful as a series of heat balances of various plants with different equipment and different modes of operation.

Figs. 1, 2, 3 and 4 are such heat balances. They are ideal heat balances and probably fit no one steel plant in existence. By that statement is meant that in one plant the blast furnace be more economical, and the open hearth less economical; in another plant, the pig to scrap ratio of the open hearth furnace will be different from the value upon which the ideal heat balances were based; in still another plant, heating furnace practice may differ from the assumptions, and so on. Nevertheless, the heat balances are representatives of different types of plants and are comparative. They were computed by Mr. J. D. Keller under the direction of the author.

Enough data are given with each set to judge the assumptions upon which each balance is based. Accordingly, very little comment is necessary. The following remarks may, however, be helpful. Fig. 1 shows the distribution of heat in a type of plant which was quite common 25 years ago, when coal floated down in barges on the Monongahela River at 65 cents per ton. The coking loss of the beehive ovens is included. On the basis of coal with a heating value of 13,000 Btu. per pound, a plant of that type used 2¼ pounds of coal per pound of finished steel. If sheet mills or wire mills are added, the additional reheating and the increased power consumption require additional coal.

Fig. 2 is the heat balance of what may be termed an average American steel plant. This term does not signify the average plant as it is being built today, but the average of those which are now in existence. The plant is assumed to have a by-product coking plant All mills are driven by steam engines, but most of the auxiliary equipment has been electrified. A rather poor vacuum has been assumed, because, with engines and with long lines of barometric condensers, the equipment is somewhat difficult to maintain and is frequently neglected. On the basis of 13,000 Btu./lb. of coal, the coal consumption per pound of finished steel equals 1¼ pounds. This particular heat balance will probably be criticized, because every steel works engineer who goes over it will notice that his own plant differs in this or that from the conditions of the ideal average plant and will feel that some changes should have been made to adapt the heat balance to that plant in which he is interested

Fig. 3 was drawn for a type of plant of which there is probably none in existence today. It demonstrates what can be done in a plant in which excellent practice exists with regard to the blast furnace, the open hearth, the heating furnaces, and boilers, and in which steam engines operated at high pressure and with superheat are used for all the main drives and for blowing purposes, it being understood that all auxiliary equipment is electrically operated. The fuel consumption, under these conditions, comes down to 1.065 pounds of coal per pound of finished steel.

Fig. 4, finally, shows what can be done if a blast furnace and steel plant are equipped with the most economical equipment known and are operated in the most economical manner. The only fuel saving equipment which is not included in Fig. 4 is that of waste heat boilers on the gas engines. The plant is equipped with gas blowing engines and with gas-electric engines in a manner similar to the Gary works of the Illinois Steel Company, or to the Minnesota Steel Company in Duluth. Using again the value of 13,000 Btu./lb. of coal, we find that the coal consumption has been reduced to 0.89 pounds per pound of finished steel. Compared to the uneconomical plant, the fuel saving (figuring coal at $3 per net ton) equals $4.50 per gross ton of finished steel.

A few words should be said about the extent to which the heat balances apply to actual conditions. They do not take care of fuel for the yard engines, neither do they include fuel for auxiliary shops such as roll turning shops, pattern shop, machine shop, and foundry. They do not include Sunday losses due to bleeding of gas which cannot be used. Neither do they include coal for heating in the winter. These additional fuel requirements vary from plant to plant. They may tentatively be estimated to equal one-tenth pound of coal per pound of finished steel.

Heat balances of blast furnace and of steel plants form one of the subjects of instruction in Prof. Trinks' class in the "Mechanical Engineering of Steel Works," given in the night school at the Carnegie Institute of Technology during the coming winter. The course includes the mechanical engineering of the blast furnace, the mixer, the converter, the open hearth, heating furnaces, rolling mills, and forge plants. It does not include roll pass design.

The heat balances are worthy of some study. They show that in every case additional coal must be used besides that which is being delivered to the coke works. If a leaner ore is used, the coke consumption per ton of pig iron rises, and a point is reached where no additional coal is needed. That condition exists in most of the Southern plants in the United States. If the ore is still leaner, there may be an excess of heat available, particularly if more pig iron and less scrap are used in the open hearth than is indicated in the heat balance.

It is interesting to note that a plant which uses steam engines all the way through, with the exception of auxiliary equipment, can be made very economical, provided the rest of the equipment and operation is conductive to economy. If the power is generated in large steam turbines and is distributed electrically there will be an additional fuel saving, but it can only be slight, which fact will readily be seen from comparison of heat balances (3) and (4). It must be remembered that, in the latter case, both the blowing engines and the electrical engines are of the most economical type in existence.

The fuel economies which differentiate heat balance No. 4 from heat balance No. 1 are not confined to any one part of the works. They are the sum of heat economies in the blast furnace, in the mixer, in the open hearth furnace, in the heating furnaces, in the mill, and in the generation and use of power. In the introduction of fuel saving devices, steel works managers will, of course, first turn to those parts of their plant in which the greatest saving can be made with the least expenditure of money and effort.

Going back to the first paragraph of this article, concerning location and type of steel plants, we observe

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that, originally, blast furnaces and steel plants were located near the fuel. In the United States that location was principally the Pittsburgh district. In consequence, we have in that district a large number of plants with old, very uneconomical equipment. Coincident with engineering progress, fuel economies were developed, and new plants could move away from the fuel in the same measure in which such economies were introduced. Accordingly, we find the latest and best equipped plants not in the Pittsburgh district, but elsewhere. In time, the original steel plants in that district will doubtless be remodeled and be made more economical.

The Heat Treatment of Coke

The Effect the Improper Heat Treatment of Coke Has Upon Causing "Calico" Gas and Other Difficulties in the Blast Furnace.

By S. R. GREENE
Superintendent of Blast Furnaces, The Otis Steel Company

COKE quality has been greatly improved during last few years by the use of certain methods of heat treatment of the coal charge during the coking process within the coke oven.

Practically no constructive work has been done as to the proper heat treatment of the coke after it has been pushed out of the oven in a highly heated condition. Almost every other article produced in a highly heated condition is very carefully cooled or annealed to prevent loss or to secure excellence of finished quality.

The sudden chilling of any highly heated article results in certain peculiar physical, chemical or molecular conditions. Cooling slowly to a predetermined temperature and then quickly chilling causes other properties to develop peculiar to the temperature used. Cooling slowly to a complete chill exhibits still other phenomena. These various conditions have been thoroughly investigated and are made use of in the production of ceramic, glass, iron, steel, chemical products, etc.

How about coke? In general about the only controlling feature in the treatment of coke after it has been pushed out of the ovens in a highly heated condition, is that the customer objects to paying for water and the freight upon that water. The customer admits that the coke must be cooled to prevent burning away in the open air and generally agrees to pay for not over 3 per cent of water.

This is a fortunate condition as it requires the coke producer to limit the amount of water used in quenching in order to stay within the 3 per cent limit or else an enormous amount of coke would be ruined except at coke plants where there is a scarcity of water. The laws of Nature also tend to prevent the ruining of a great deal of coke due to the fact that when water is soused upon a body of hot coke that there is a great evolution of steam as the water penetrates the coke mass. This steam in escaping tends to prevent much water from penetrating deeply into the coke mass so that what water and steam does penetrate, cools the interior of the coke mass sufficiently to prevent burning away but fortunately leaves it hot enough to impart its excess heat back to the outer chilled over-quenched portions of the coke mass and by the annealing process thus set up a large part of ruined coke is restored to proper quality.

With the development of larger oven capacity came the requirement of larger quenching car capacity. Engineering difficulties necessitated the increase of car capacity by depth of coke volume instead of increased length of car. The deeper the coke mass the greater difficulty for the quenching water to penetrate deeply, thus accidentally less coke was ruined in the quenching process.

These conditions of customer's objections to paying for water and the deeper coke mass in the quenching car have prevented the production of an excessive proportion of chilled or over-quenched coke, yet it is probable that every oven pushed into a quenching car contains a considerable portion of ruined coke, not enough to cause a disastrous effect upon the blast furnace, yet enough to appreciably affect the coke consumption, as enough extra coke must be used to make up for the over-quenched part of the charge.

When over-quenched coke is charged into a blast furnace the first effect will be noticed at the stoves and boilers where the furnace gas is burning, when such coke has reached a depth of 15 to 20 feet below the stock line, the burning gas begins to show what is known as "calico" gas. This is a flame throughout which there are numerous small bright independent flames having a curly or wormlike appearance. As the charging of over-quenched coke continues the general flame of the burning gas is replaced by a white smokey gas or fume throughout which the small wormlike flames continue to burn, this is followed by a dense white smokey gas or fume that does not burn at all in the boiler fire boxes or furnaces, though it may burn out the top of the boiler stacks. The stoves show no evidence of this gas as burning, though it must burn high up in the combustion chamber because the stove gains heat while on gas.

In these later stages the furnace gas is found to contain high percentages of carbon monoxide with corresponding reduced carbon dioxide content.

Immense volumes of dense white gas are emitted from the boiler and stove stacks giving somewhat the appearance of a furnace that is excessively hot. The furnace itself becomes cold at the hearth and produces cold off grade iron.

The logical conclusion is that the over-quenched coke contains carbon of such a quality that it readily combines with the carbon dioxide gases at comparatively low temperatures near the top of the furnace. The reason that the furnace goes cold at the hearth is

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that ont enough carbon gets down to the tuyeres to keep it hot, and the reason that not enough carbon gets down to the tuyeres is that a good deal of it has gone out the top of the furnace in form of carbon monoxide gas.

It is reasonable to expect that every coke plant using the regular accidental heat treatment of quenching in a quenching car, produces percentages of coke that when charged into the blast furnace quickly makes its escape from the furnace in form of carbon monoxide gas. While the percentage may be small, it is nevertheless lost for metallurgical purpose.

There is a prevailing idea that the percentage of moisture in coke determines whether the coke was or was not properly quenched.

The falsity of this idea was proven several years ago by experiments extending over a period of several months. The experiment consisted of pushing 16-inch ovens producing 6 to 8 tons into two quenching cars so that the effect of various depths of coke volume with regard to quenching could be noted. With a thin bed of coke about 18 inches deep along the discharge side of the cars, by passing the cars slowly under a quenching nozzle, quenching to blackness but still leaving the coke hot enough so that the moisture was driven off within a few minutes, over-quenched coke of less than 3 per cent moisture content was obtained. Under same conditions passing the cars quickly under nozzle and using the least amount of water that would prevent the coke from burning which left the coke at a low red heat, then allowing the coke to cool to blackness by atmospheric cooling and finally sousing to a complete chill, the resulting coke while it contained 12 to 14 per cent moisture showed no evidence of overquenching when used in the blast furnace.

In ordinary practice the coke may be piled high in parts of the quenching car and low in other parts, very irregularity of quenching may be produced in one car with detriment to a portion of the coke.

During the period of these experiments overquenched coke was deliberately produced and charged into the blast furnace with the results already described.

Though the preceding comments refer to by-product coke methods, the beehive producer frequently ships out coke that causes the production of "calico" gas and furnace difficulties, though in general using an entirely different method of quenching the coke.

Great improvement in quality or quantity of perfect product has been accomplished in the manufacture of many articles by using rational methods of heat treatment and there is no doubt that great improvement in metalurgical coke can be expected as soon as some intelligent heat treatment is devised in place of the present crude accidental methods forced upon the coke producer by commercial and engineering conditions.

Pyrophoric Flue Dust

Abstract of a Preliminary Report on a Study at Wissen to the Blast Furnace Committee of the German Eisenhiittenlente (Iron and Steel Institute).

By DIPL. ING. J. W. GILLES, Wissen

Stahl und Eisen, June 28, 1922

IT has been noticed for decades that the fine dust deposited in the gas passages of the stoves will glow on exposure to air; and this property now demands special attention because of the difficulties it offers in dry cleaning the gas by filtering. Whole chambers were burned out when changing tubes if they stood open too long. This difficulty has been overcome by quick work in changing tubes and keeping air away from the dust. The filtered gas is very clean and burns with a clear blue flame.

Whenever the top temperature is high, streams of sparks escape which consist mainly of reduced metal; and similar sparks show when cleaning the sacks nearest to the furnace, while the main bulk of the dust lies unburnt although it contains some 15 per cent of carbon. This sparking is a different matter from the quality of the dust in igniting itself. Pyrophoric dust is found even in the coarser material deposited close to the furnace. This dust, especially when the blast is low, will begin after some time, hours or days, to burn and this action is intensified by stirring, and is stronger the finer the dust. The filtered material contains the finest dust and shows the property most strongly. A cubic meter of the filtered dust weighs from 260 to 350 kilos against 1,500 kilos for the raw flue dust. Fineness is thus an important requirement of pyrophoric dust. When the Wissen flue dust is strongly compressed into cakes with a slaty cleavage, the flame of a Bunsen burner will ignite only so much of the cake as is in direct contact with the flame, the combustion not spreading further.

The extremely fine, loose dust is drawn from the filter tubes at about 80 deg. to 90 deg. into a collector vessel, often being taken from this vessel barely warm to the hand. There then follows a lively temperature increase which usually on stirring starts a glowing. The blue gray color of the dust in burning changes to reddish and an unpleasant suffocating vapor is given off. CO_2 and ammonia are present and a very fine white fume which has the characteristic evil odor of the dust, but which is very difficult to filter or precipitate out.

If the filtered dust is allowed to cool away from air it can later be exposed to the air without igniting itself. The flame of a match will ignite this dust and the glowing will then extend by zones throughout the whole mass.

Abstracted by S. L. Goodale, Professor of Metallurgy, School of Mines, University of Pittsburgh.

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The ignition temperature of this dust is 167 deg. to 220 deg., the higher figure being for an old sample, fresh dust kindling more easily. The temperatures cannot be determined very exactly, but the difference shows that the dust loses on storage something of its self-igniting quality. The dust is sold as a potash fertilizer and sometimes will start burning slowly in the storage sheds when stirred up as in shipping.

The highest temperature reached in this combustion is 600 deg. A bomb calorimeter test showed 473 calories evolved per gram of dust, but this figure is probably high, as the oxidation in the bomb goes to a higher stage than in air.

If the filtered dust is heated in illuminating gas or hydrogen the white vapor and bad smell come off, and if the heating were enough, the dust glows on exposure to air. Some hours heating above 200 deg. in CO_2 causes slow oxidation and changes the color to red. The pyrophoric character disappears.

From several tables of analyses of various flue dusts gathered for comparison, some being pyrophoric and others not, no conclusion could be reached as to which constituent caused the pyrophoricity.

Some 3 per cent of iron is present in the Wissen flue dust, but no magnetic particles occur, and none can be identified as metal. The sudden burning of a dust at the Nennkirchnir works ordinarily not pyrophoric was due to metallic iron, but there some 24 per cent was present. Further experiments showed that neither zinc nor carbon was a probable cause of self-ignition.

The managnese content at Wissen and at some other places is remarkably high and Erdmann states that finely divided MnO will oxidize in air. The Mn is present in part in the flue dust as free MnO, a part of which on burning is oxidized to a higher oxide. MnO produced by heating $MnCO_3$ in CO_2 and in illuminating gas showed strongly pyrophoric, the ignition temperature in both cases being 182 deg. It may be concluded therefore that free MnO is present in the dust and is the cause of the pyrophoric property. At the Burbacher works the dust was especially pyrophoric when gases from a ferromanganese furnace were added to gas from a furnace on basic Bessemer iron. Analysis of some recent dust from Wissen that was but little pyrophoric showed less Mn and less S as sulfid, and more iron than in strongly pyrophoric dust. It has been observed by the gas cleaners that with higher gas pressures the dust is less pyrophoric. Other dust samples high in manganese but not pyrophoric are shown not to contain free MnO, but to become pyrophoric when heated to 500 deg. in a reducing gas, the ignition temperature then being 260 deg. to 270 deg.

The Wissen dust shows a high sulfid S content, which on burning goes over to sulphate, but the ignition temperature of dry fine iron sulfid is 350 deg. to 370 deg.

The conclusion is reached that MnO is the chief cause of the pyrophoric quality of the Wissen dust; also that while the fresh warm dust will ignite spontaneously the dust cooled away from air will not ignite until heated to 180 deg. because of superficial oxidation. Other oxidizable bodies strengthen the phenomenon when once started by their evolution of heat. Also it is possible that some constituents of the dust act catalytically to strengthen the pyrophoric quality of MnO.

Director Harr of Hordee reported, in discussing Dr. Gilles' paper, that their chief chemist had carried on investigations which made it seem probable that MnO, or still more likely FeO, was the real cause of the spontaneous combustion. Certain samples of flue dust were treated so as to remove all other possible pyrophoric constituents except the FeO and were then found to have just the same pyrophoric qualities as before the treatment.

THE MARCONNET FUSED-ASH GAS PRODUCER FOR GAS-COKE SMALLS.

A review is given of a paper recently contributed to the annual conference of the Societe de l'Industrie du Gaz en France, by M. G. Riviere.

It would appear that to fuse the ash, high temperatures are essential, and application has been made by a French company of the ideas advocated by M. Marconnet.

The chargers are at the top, the upper part being of refractory brickwork, whilst the lower presents water-jackets, which allow a series of orifices for cold air blast, for poking-up, and for steaming. There is also an arrangement for knocking the mass together. The gas produced emerges at the top, and is freed from dust by a baffler.

The various cokes used varied in their percentage of ash, and particulars are given of the results obtained, which were perfectly satisfactory.

Gas-coke smalls can be gasified by a cold blast, scurfing becomes unnecessary, and the fused ash granulates beautifully when falling into water. The thermic efficiency is good ,the latent heat of the gas being 71.4 per cent, and its sensible heat 12 per cent of the heating value of the coke used. Coke-smalls are enabled to be used up in the gas works, instead of the larger-sized coke usually employed in the producers.

CONSTRUCTION PROPOSALS FOR THOMAS CONVERTER

Bruno Versen, in a recent issue of Stahl und Eisen, has the following to say regarding the Thomas converter:

A great defect in the Thomas process is the amount of losses; these it has been proposed to avoid by reducing the period under blast. The losses are due, generally, to the fact that the convertors are too small for what they are supposed to hold, and also to excessive blast pressure. In the effort to equate the necessary amount of blast to meet the continually increased charges, the pressure has been raised to 2½ atmospheres and mire, instead if enlarging the cross-section of the convertor; the amount of blast is then increased in such a way as to obtain steady working. The whole cross-section should bear a certain minimum proportion of the surface under blast, represented by the nozzles at the bottom; this minimum proportion should be 3½.

The blast pressure should be calculated, commencing with the indispensable volume required, and the total nozzle section necessary to deal with same, not forgetting the considerable resistance loss, which is estimated to be not under 60 per cent.

In estimating pressure, one has to consider the charge of iron and slag, as well as a certain surplus pressure, for which, to ensure the escape of the blast, and also a working reserve, allowance must be made.

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New Plate Mill For Granite City Plant

The National Enameling & Stamping Company Has Ordered from the United Engineering & Foundry Company Modern Plate Mill Equipment.

By M. E. GRIFFIN

THE National Enameling & Stamping Company located at Granite City, near St. Louis, Mo., have recently placed an order with the United Engineering & Foundry Company for complete new plate mill equipment. The plans for this new plate mill are of more than usual interest because of the fact that many important improvements are incorporated in its design.

The company has at present a two-high engine-driven plate mill. To the approach table of this mill they are adding a furnace table 43 ft. 9 in. long with 12 x 41 in. rollers driven by a 40-hp. motor. The slab, or ingot, is discharged from a continuous furnace to this table from which it is fed to the two-high mill where it is roughed into slabs of a thickness that depends upon the thickness of the finished plate.

Part of the old leveller approach table is to be removed and in its place, the new three-high plate mill and mill tables will be located.

The top and bottom rolls of this mill are 34 in. diameter, the middle roll 22 in. diameter and the face of all three is 100 in. Plates from No. 10 gauge to 1¼ in. thickness will be rolled. Frequent roll dressing is required in order to keep a smooth surface on the finished plate and, to redress the rolls, they are removed from the mill and re-turned and ground.

A new design middle roll operating rig is being furnished, the main feature of which is the ease with which roll changing is accomplished. In this design, the arms carrying the middle roll, and hydraulically operated, are not removed from the mill but are disengaged from the roll and rocked back from the mill towards the table, leaving the entire window opening unobstructed.

The top roll is balanced by means of a hydraulic cylinder placed above and connected to the balance beam and roll bearings by easily removable hanger bars.

A 60-hp. motor is required for the screw down

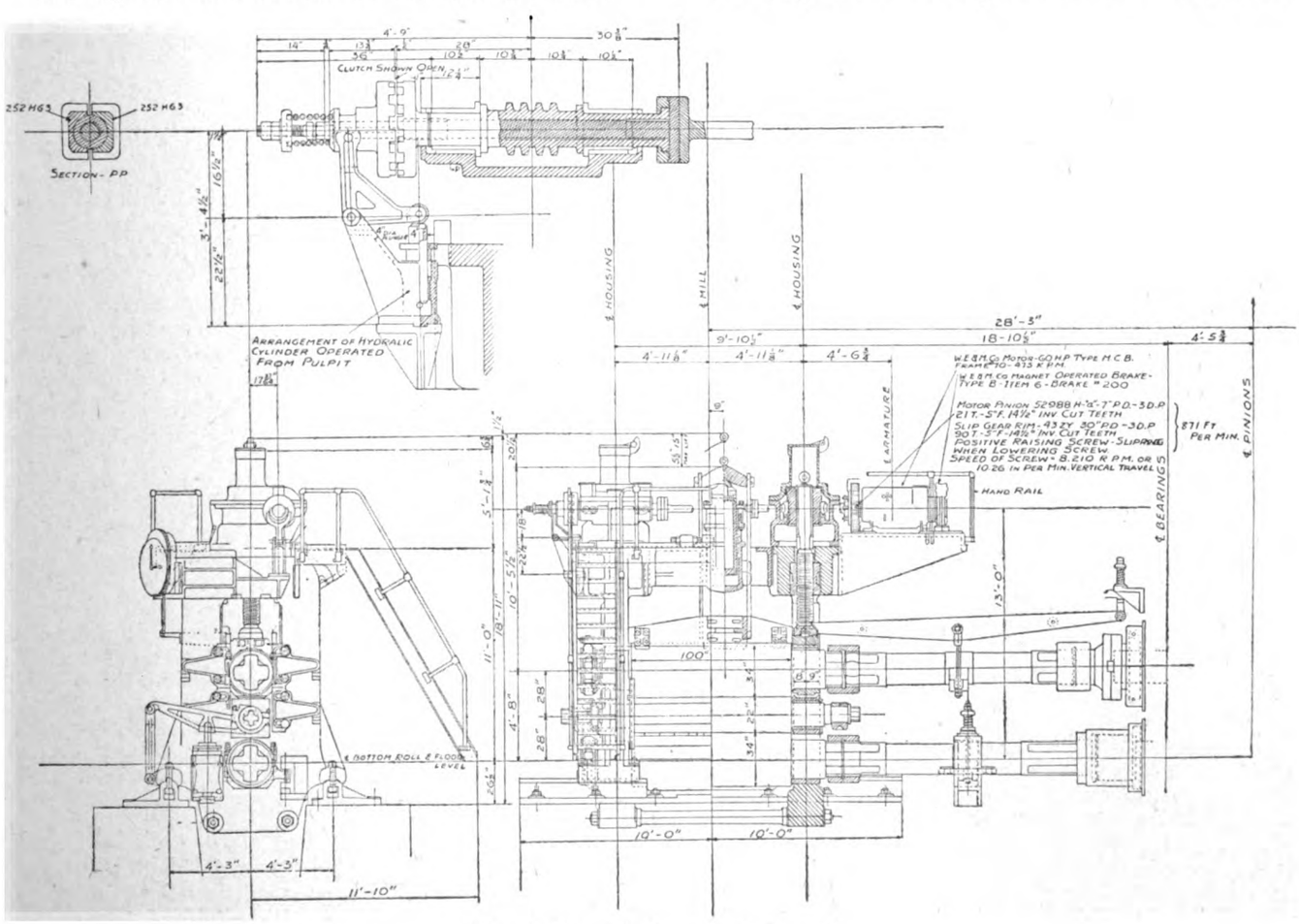

Fig. 1—Plan of the new plate mill.

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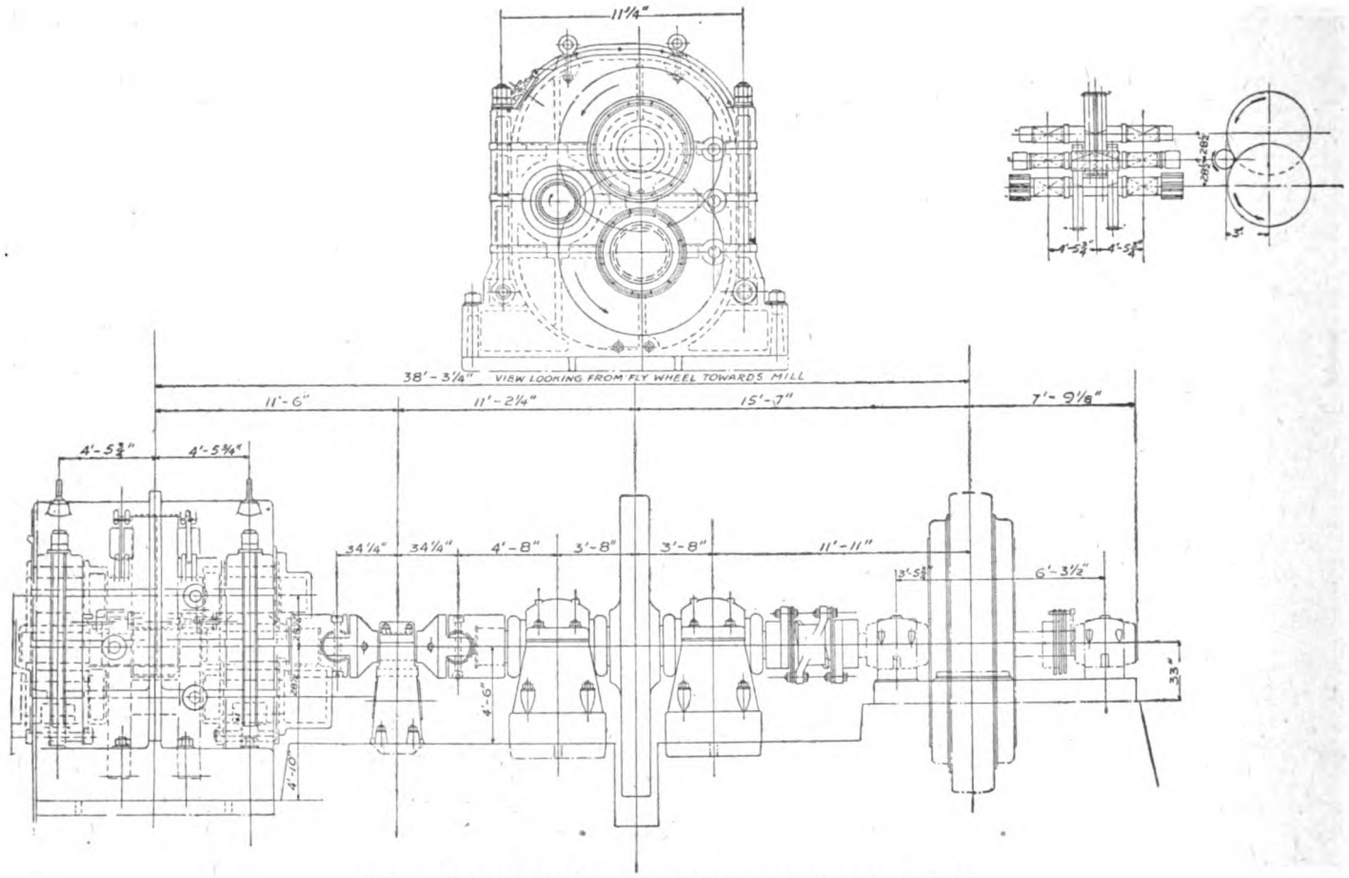

Fig. 2—General arrangement of pinion stands and flywheel.

which is of the worm and worm wheel type. In order to keep the space between the entire length of the rolls the same so as to insure uniform thickness of plate, a clutch is used in the worm shaft so that one screw may be operated independently of the other. This adjustment must be close and be made frequently. A hydraulic cylinder permits operation of this clutch by simply opening a valve placed in the pulpit or other convenient location.

An 8 in. accumulator of about 5 foot stroke to maintain 500 pounds per square inch water pressure is furnished for the operation of the cylinders.

The pinions are cut with double helical teeth and arranged so that 4½ to 1 speed reduction is attained, eliminating a separate gear reduction set, and therefore considerably reducing the floor space.

The heavy flywheel provided to take care of the main peak load is cast steel of the umbrella or mushroom type and a Tod type universal spindle connects it to the main driving pinion. The flywheel is connected to the motor by a flexible coupling. The motor is 3000-hp., 2200-volt, 3-phase, induction type with a speed of 235 rpm., giving a mill speed of 52 rpm.

In a three-high plate mill the slab is passed first between the bottom and middle rolls, with the middle roll held up against the top roll by the aforementioned operating rig; the middle roll is then lowered and the piece raised by the table and passed back between the top and middle rolls, the middle roll being in contact with the lower roll. The middle roll is then raised, the tables lowered and another lower pass made and this is repeated until the plate is of desired thickness. To accomplish this raising and lowering of piece, tilting tables are used. The old type of cast table girder has been discarded and a rolled steel slab, machined to an I section, used. Each of the tilting tables is 27 ft. 6 in. long with 17 disc type rollers driven by an 80-hp. motor. The mitre gears are forged steel with cut teeth. Contrary to the older designs, there is but one line shaft and one motor on each table. The tilting tables are roller bearing equipped.

These tables are operated by our patented air hydraulic system. The ends farthest from the mill are supported on massive rocker stands or trunions while the mill end is carried on levers mounted on shafts. By means of hydraulic cylinders operating through levers on the outer ends of these shafts and connected by a link, the tables are balanced.

These cylinders are piped to a vertical tank partially filled with water. The upper end of this tank carries air at a sufficient pressure to balance the tables in mid-position. Two series connected 100 hp. motors geared to the lever mechanism serves to operate the tables. When lowered, the water is forced from the cylinders into the tank, further compressing the air. This results in an over-balance, cushioning the tables at the bottom of their down stroke and relieving the motors of part of their work in starting the up-stroke. As they rise the pressure lowers, decelerating them towards the end of the stroke and leaving them underbalanced. This underbalance operates to help start the tables downward.

Two plate shears are also to be installed. One is a No. 6 108 in. with a capacity to cut 1⅛ in. plate, and the other a No. 4 156 in. for cutting 9/16 in. plate. These shears are equipped with oil gags, but are so arranged that magnetic holddowns may be added.

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Special Drive Designed For Plate Mill

Main Motor Drive for New 100-in. 3-High Plate Mill for the National Stamping & Enameling Company

By F. D. EGAN*

THE National Stamping & Enameling Company has a 2-high 90-in. reversing plate mill, engine driven, and in order to increase the output as well as the finish of the plate and to be able to roll plate to thinner gauge, they are installing a 3-high 100-in. Lauth type finishing stand to be located 75 ft. beyond their present mill. The arrangement and method of rolling will be similar to that employed at the 84-in. tandem plate mill of the Brier Hill Steel Company, roughing the ingot or slab to width and suitable thickness for entering the finishing stand in the 2-high roughing mill and finishing to proper gauge in the Brier Hill Steel Company's 84-in. tandem plate mill, which holds records for the number of slabs rolled per hour, per day and per month, as well as thinness of gauge for the width of plate rolled, having rolled 220 slabs per hour, 1,659 slabs in 12 hours and 3,270 slabs in 24 hours.

The main motor for driving the 100-in. 3-high stand of this tandem plate mill will be especially designed for a drive of this character, as the motor will be subjected to very severe service. To meet this condition, the pedestal bearings will be designed low and very rugged. The motor is rated 3,000 hp., 40 deg. C., 2,200 volt, 3 phase, 60 cycle, 236 rpm., and will develop a starting and pull out torque of 2½ times full load torque corresponding to 7,500 synchronous hp. It is of the wound rotor induction type and is shown in Fig. 1.

From an examination of the photograph showing the motor it will be noted that it is designed with the supporting feet near the horizontal center of the plane and cast integral with the frame. The feet have screws and liners for horizontal and vertical adjustment so that the stator can be moved by fine increments in any direction for the purpose of lining up the air gap, and to compensate for any wear of the bearings. The laminations are dove-tailed into ribs in the frame casting and are clamped between heavy end plates with fingers for supporting the teeth. The slots are of the straight open type and the winding is composed of duplicate coils completely formed and insulated before being placed in the slots. Before the coils are placed in position the slots are lined with fish paper cells which prevent the coil insulation from coming into direct contact with the iron, thus protecting it during the process of assembly. To seal all the joints in the insulation and guard against metallic dust prevalent in steel mills, the entire winding receives several treating processes with special insulating compounds. In order to withstand mechanical vibration and surges due to switching and extreme fluctuations in load, the coils are strongly braced. The slot portions of the coils are held in place by hard fibre wedges driven into grooves in the sides of the teeth, and the coil ends are braced by lacing each coil to an insulated steel ring supported by the stator frame.

*General Engineer, Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa.

The rotor is to take the brunt of the shocks and vibration transmitted from the mill pinions. It also must be capable of withstanding the severe unbalancing strains set up when the motor is "plugged," i. e., reversing from full speed in one direction to make a quick stop. For this reason the rotor is built up on a rugged double arm cast steel spider with the laminations dove-tailed into the spider and clamped between heavy end plates with fingers for supporting the teeth. A special feature found in Westinghouse rotor slot and coil construction is the use of form wound coils similar to those used in

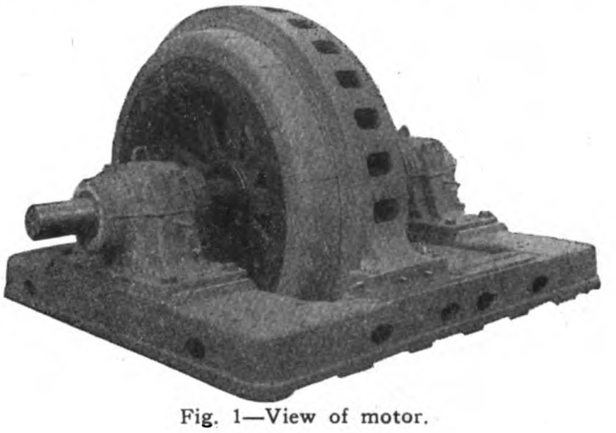

Fig. 1—View of motor.

straight open slot construction. The rotor coils are made up of two straps side by side, each strap being formed to exact shape and completely insulated before assembly. The use of partially closed slots gives a high power factor without the disadvantage of a small mechanical air gap, and at the same time permits the use of completly formed and insulated coils. The opening at the top of each slot is sufficient to allow one fully insulated strap to be dropped in one at a time and there is no forming and insulating operation performed after the coils are put into the slots. This method of assembly gives excellent insurance that a good job is being done at the factory and facilitates the removal of coils for repairs in case of accident.

A motor of this size has a wide core and the question of proper ventilation was given special attention. The core is provided with radial air ducts placed at frequent intervals through which the cooling air is forced by the centrifugal action of the rotor. These air ducts have been made liberal in size so as not to become clogged with mill dust and to facilitate blowing out when cleaning the motor. In addition the rotor carries a fan on each side and the end plates bolted to the sides of the frame are shaped to guide the air supplied by these fans around the coil ends to the back of the stator core where exhaust openings are provided in the frame. The entire system of ventilation is designed to bring the cooling air in

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direct contact with all parts of the machine where heat is generated, thereby preventing "hot spots."

The pedestals are ruggedly built with low bearing centers in order to give strength and rigidity necessary to take up the shocks and vibrations from the mill. The bearings are designed with high grade babbitt lined shells and are designed to operate with oil ring lubrication alone. As an additional safety measure, however, both bearings are arranged for gravity oil lubrication. Each

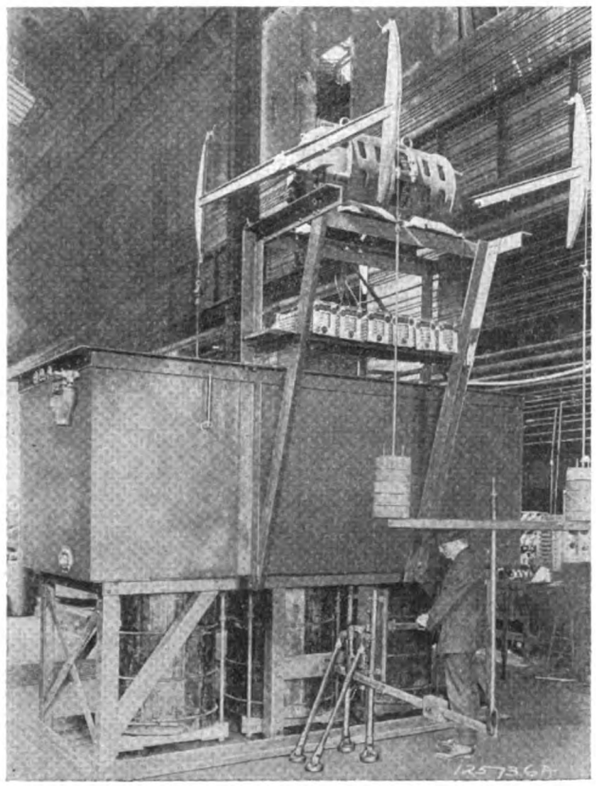

Fig. 2—Liquid slip regulator.

one is split horizontally and so designed that the top half can be readily removed for examination of the journal, and the bottom half rotated out by relieving the bearing of the shaft weight. The bearings are made dust proof by means of felt packing at the oil hole covers and around the shaft.

The bedplate which carries the stator and the pedestals is made of cast iron of heavy box type pattern. The machine surfaces under the frame feet are extended to one side and are provided with barring holes so the stator may be slid parallel to the shaft, thereby giving free access to both stator and rotor winding.

Control.

The controller will consist of a primary panel and a liquid slip regulator for the secondary control. The primary control is designed with electrically operated 1,200-ampere circuit breakers, one for forward and one for reverse operation. Both breakers to be controlled from a two point master controller located in the operators' pulpit. In order to determine the power requirements and input to the drive of this mill, there will be provided an indicating voltmeter, a wattmeter, a watthour meter and a curve drawing wattmeter. For protection there will be provided two CO overload relays and one CV no-voltage relay.

The liquid slip regulator shown in Figure 2 for the secondary control of this drive consists of a steel plate tank, to the bottom of which are attached three insulated cells. On the bottom of each cell is a stationary electrode. A movable electrode is suspended in each cell, these electrodes being hung from a common cross bar, which in turn is suspended from two arms mounted at the top of the tank. The rotor of the torque motor is mounted on the shaft of the rotating arms. The arms extend to the rear and are provided with adjustable counterweights, which do not quite balance the weight of the electrodes. One secondary lead of the main motor is connected to each stationary electrode. The movable electrodes are tied together mechanically and electrically by the supporting cross bar, which serves as a star connection. The circuit is completed through a solution of soda contained in the tanks and cells. Fig. 3 shows a section through the regulator, also a schematic diagram of the regulator connections.

The torque motor, which is of the wound rotor type, is supplied with energy from a 3-phase series transformer, the primary of which is in the primary circuit of the main motor. This motor is so connected that its torque is in the same direction as that of the counterweights, that is, it tends to raise the movable electrodes. The torque developed by this motor is proportional to the square of the current flowing in its windings, and therefore to the square of the current in the primary of the main motor. This condition makes the equipment very sensitive and causes it to give immediate response. An auxiliary arm with a weight attached is mounted on the torque motor shaft in such a way that if released it drops and adds its weight to that of the counterweights,

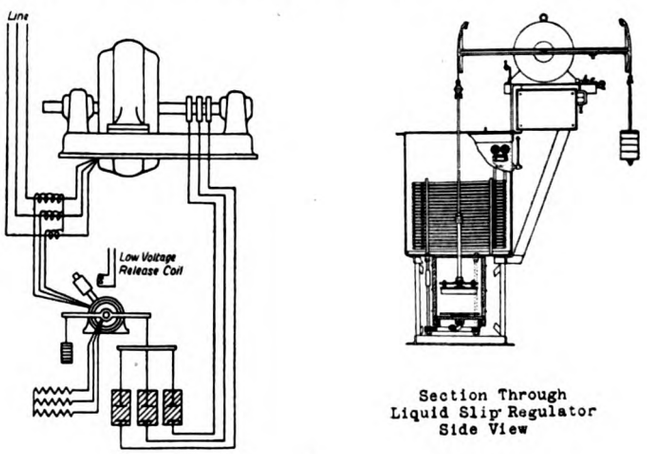

Fig. 3.

raising the movable electrodes to their highest position. When operating, this arm is normally held up by a low voltage release coil connected across the primary of the main motor circuit.

The liquid slip regulator is used both for starting the main motor and in connection with the flywheel for limiting the peaks on the main motor while running. Whenever power is off the main motor the voltage release coil is de-energized and the electrodes are held at their highest position. Under this condition the resistance in the secondary circuit is a maximum. In starting the motor the primary circuit is first closed. This places power on the primary with all resistance in the secondary circuit, in addition closing the circuit

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that raises the auxiliary arm, which is then engaged by the voltage device. Raising this arm releases the moving electrodes which start to descend. As the electrodes approach each other the resistance between them becomes less and the current in the primary of the main motor increases, increasing the torque of the torque motor. At some point the torque, due to the weight of the electrodes, will be just balanced by the compound torque of the torque motor and counterweights and the electrodes will float at this point. As the motor accelerates this condition of equilibrium is maintained, the electrodes approaching each other at a rate which maintains the input to the main motor at a constant value. When the motor reaches full speed the moving electrodes are at their lowest position and the secondary practically short circuited.

When rolling is begun the regulator automatically limits the motor input to the value for which it is set, and with the proper relation between the flywheel effect and load, will maintain approximately constant input. When the input tends to exceed the value for which the regulator is set, the torque motor causes the electrodes to separate, thereby introducing slip resistance into the motor circuit, causing a corresponding reduction in speed and allowing the flywheel to take the peak load. After the peak is past the torque motor allows the electrodes to approach each other, still maintaining the load at constant value until the motor again reaches full speed. The value of the load at which the regulator will open is easily adjusted to follow ordinary operating conditions by varying the number of counter weights. In addition the series operating transformer is provided with 80 per cent, 100 per cent, 125 per cent and 150 per cent taps to take care of larger adjustments.

In case a quick stop is desired the motor can be plugged. To do this the master controller is thrown from the forward to the reverse position, thus dropping out the primary circuit breaker for forward operation, and after the electrodes have moved to their highest position, the reverse breaker will automatically close, thus reversing the power on the main motor, which will quickly bring it to rest.

The Trend of Specifications for Steel Castings

General Discussion Covering the Important Features of Steel Castings Specifications Such as Chemical Composition, Physical Properties, Ductility and Testing.

By E. R. YOUNG*

STEEL castings from the standpoint of specifications governing physical and chemical properties, may be divided into two classes: Unannealed and annealed castings.

For unannealed castings, specifications are not ordinarily employed. In some cases the limits for chemical composition are set down in order to insure that the product will be of commercial grade and of a hardness which is readily machinable. Of course, there are special cases where a definite chemical composition is required in order to obtain certain specific properties, such as resistance to abrasion, magnetic permeability or occasionally a maximum tensile strength and where the castings may be desired in the unannealed condition. While there are specifications which cover the physical properties of unannealed castings of soft steel, it is for annealed castings that almost all of the specifications containing physical property requirements are employed.

In the early days of the industry a great number of the castings produced, and probably the majority of them, were used unannealed. When annealed material was desired it was so specified along with the physical properties which should be developed. With the increasing consumption of steel castings and the increasing variety of their uses, there has been, naturally, an accompanying refinement in quality of product, until now it is only the exceptional casting which is not annealed, unless that process be specifically waived by the purchaser. However, it is still the usual practice to specify that the castings be annealed as a preliminary to enumerating the physical properties desired, although as a matter of fact it is practically impossible consistently to meet the present ductility requirements with unannealed material, excepting perhaps the specifications for castings of soft steel.

In this progress toward higher standards, the physical property requirements specified as desirable from time to time have led the way so that steel castings are now being successfully produced under specifications which would have been considered commercially hopeless some years ago. At this time, it is interesting to survey the present standard specifications, to consider to what extent they secure what they aim to secure, to discuss some proposed changes, and to venture an opinion as to the logical course of revisions.

Chemical Composition.

One of the mooted questions in the steel industry and one which concerns the steel casting manufacturer is the question of the limits of phosphorus and sulphur. Earlier specifications set these limits at 0.050 per cent for acid open hearth steel and these were commercial up to the time of the war demand. When fuel and melting materials which would yield a finished product under these limits became difficult to secure and were

*The author is connected with the Sales Department of the Detroit Steel Castings Company, Detroit, Mich.

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needed for types of steel in which low phosphorus and sulphur were of vital importance, the phosphorus and sulphur limits for steel castings were raised to 0.06 per cent for acid steel. These limits were tentatively continued in 1919 and were adopted as standard in 1921 by the American Society for Testing Materials. Some purchasers, however, are still loath to adopt this new limit. The findings and recommendations of the joint committee on phosphorus and sulphur in steel which is now making an exhaustive study of the subject will undoubtedly prove the limits of 0.06 per cent to be entirely proper for steel castings and will probably justify a more liberal limit. It is to be hoped that this report, when forthcoming, will be of such a nature as to be conclusive on the subject and that it will be accepted as standard by all. In the meantime, the writer cannot refrain from offering some observations on the subject.

It is safe to state that the objection of the average engineer or metallurgist to steel with phosphorus and sulphur over 0.05 per cent or 0.06 per cent is based partly on tradition and partly on a mental reservation regarding the shock strength of the material. It is this objection to phosphorus and sulphur based on tradition or perhaps even on prejudice which the findings of the joint committee will surely answer.

Phosphorus from 0.04 per cent to 0.06 per cent and sulphur from 0.05 to 0.07 per cent do not affect the static properties of annealed steel castings, that is the properties determined by the usual tensile and bending tests.

The writer has the data on the physical properties and chemical composition of 1,036 heats of ordnance steel (cast steel No. 2 and No. 3 U. S. Army specifications) made by the converter process, which has been analyzed to detect any variation of tensile properties with the phosphorus or the sulphur content. Four divisions or classes were made as follows:

Heats low in phosphorus—(under 0.040%)
Heats high in phosphorus—(0.055% and above)
Heats low in sulphur—(under 0.055%)
Heats high in sulphur—(0.07% and above)

The heats were segregated according to this classification and the average tensile properties and chemical composition of the heats in each class were computed. The table below gives the average properties and composition, and the number of heats included in the average in each case.

The average properties show a sensitive relation to the carbon and manganese content as would be expected. There is no suggestion of any relation to the phosphorus or the sulphur content with the possible exception of the value for yield point for the high phosphorus heats which is slightly out of line with the other average properties for these heats. This is very likely due to the average including a relatively small number of heats, and so, being unduly affected by a few low values; but, in any event, the decrease is well within the limits of error of testing and therefore unimportant.

Results of a short series of impact tests have been published which show a marked falling off in dynamic or shock strength, between .06 and .07 per cent phosphorus.* However, considering the somewhat uncertain standing of this test in the field of testing materials and, especially, the small number of tests included in the average results, it does not seem that this evidence on the subject can be regarded as final.

The writer has seen screws, bolts, etc., made of screw stock with phosphorus and sulphur both over 0.10 per cent, tested to destruction, without any weakness of material being disclosed. He has also seen steel castings with phosphorus over 0.06 per cent and sulphur over 0.075 per cent tested to destruction with no suggestion of weak or faulty material, though the uninitiated would confidently expect such tests to show the material to be decidedly inferior.

The final answer to the question of shock strength is the test of service. Perhaps there have been cases of failure of steel castings used under severe shock conditions, which have shown a high content of phosphorus and sulphur in the broken parts. Supposing that these failures have been shown to be due to faulty material and not to foundry defects or to excessive loading, the remedy is still not lower phosphorus and sulphur, but proper heat treatment. In the writer's opinion this has been conclusively shown by the work of Mr. John H. Hall and associates on the "Heat Treatment of Steel Castings."† They have shown that the lines or planes of weaker material, due to the non-uniformity or segregation promoted by phosphorus and sulphur, can be removed by quick cooling from the annealing heat, followed by reheating at the proper temperature, but cannot be prevented from forming slow cooling from the annealing heat, by any lower

*F. C. Langenberg, "Impact Tests on Cast Steel," Proc. A. S. T. M., 1921, p. 810.

†"Heat Treatment of Steel Castings," Amer. Inst. Min. & Met. Engrs., Vol. LXII, p. 353.

Comparative Tensile Properties of Heats

High in phosphorus, low in phosphorus, high in sulphur, low in sulphur

Classification of Heats	Physical Properties					Analysis				
	No. of Heats	Field Point	Tensile Strength	Elongation Per cent	Reduction Per cent	C.	Mn.	Si.	P.	S.
Heats high in sulphur (.070 or above)	209	44,780	80,110	22.4	28.7	.29	.71	.30	.045	.076
Heats low in sulphur (under .055)	110	45,100	80,500	22.2	29.	.30	.70	.30	.044	.052
Heats high in phosphorus (.055 and above)	32	43,700	81,000	21.7	28.0	.30	.72	.31	.056	.061
Heats low in phosphorus (under .040)	74	44,660	80,200	22.8	29.9	.29	.70	.29	.037	.065

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content of phosphorus or sulphur down to 0.025 per cent.

Further evidence that an extremely low content of phosphorous and sulphur is necessary before any gain is made in the properties of carbon steel is given in an article detailing the practice of the U. S. Naval Ordnance Plant at Charleston, W. Va., by W. J. Priestley.* He shows that an increase in the figure obtained for reduction of area on tangential test bars occurs when the phosphorus and the sulphur content are reduced below 0.020 per cent. If we agree that reduction of area is a rough index of toughness and that the usual conception of shock strength is of a property which combines toughness with good elastic limit we conclude that an improvement in shock strength is not achieved by a reduction of the phosphorus and sulphur content from 0.060 to 0.025 per cent.

It is gratifying to note that recent U. S. Army specifications for caterpillar tractor links or shoes permit sulphur to 0.07 per cent and specify a heat treatment consisting of a straight anneal followed by a water quench and a draw. The tensile properties specified could readily be obtained with a simple annealing treatment indicating that the object of the heat treatment was to improve other than tensile properties.

Occasionally it is intimated that published articles and researches dealing with the question of phosphorus and sulphur are not written entirely in good faith as technical articles, but are perhaps inspired by commercial considerations. It is certainly quite clear that any producer of steel who resorted to propaganda to market an inferior article which would not function properly would be pursuing a very short-sighted policy indeed. It is equally clear, on the other hand, that any user of steel who unnecessarily insists, through ignorance or prejudice, on a costly and relatively less common product is pursuing an uneconomic policy both personally and industrially.

Physical Properties—Elastic Limit and Yield Point Specifications.

One of the frequently proposed revisions in physical property specifications is to require a reasonably accurate determination of the elastic limit, and to make this property together with the usual ductility requirements the basis for acceptance or rejection, the ultimate strength to be reported only as an item of information.

At first thought, this plan sounds very good. It is argued that the elastic limit is the property in which we are most interested. It is the property that has been used as the basis for design and it determines the point of failure in service more often than does the ultimate tensile strength. This is all true, but there are difficulties in the way of adopting this suggestion. One difficulty is that of definition, and another that of method. When we come to the question of an exact defintion of the proportional elastic limit or proportional limit (which is the property commonly determined in actual testing and which closely corresponds to the elastic limit based on permanent set) and a method of determining it in practice, we find we have nothing hard and fast for a standard. Authorities on the testing of material state that the greater the refinement of measurement and the greater the delicacy of instruments used in determining the proportional elastic limit the lower the value obtained for this property.

*"Sulphur and Oxide in Steel," American Inst. Min. & Met. Engrs., Feb., 1922. Iron Age, Dec. 29, 1921, p. 1658.

Granted this situation is not peculiar to steel castings, but applies to other materials similarly tested. However, most of these materials, when subjected to the standard tensile test, show an almost constant stress-strain (load-stretch) ratio within the elastic range and a definite break from a straight line in the stress-strain curve which for practical purposes it is satisfactory to take as the proportional elastic limit. Actually the value obtained here is higher than that obtained in tests of greater precision and more nearly represents the yield point, which is defined as the stress at which there is a marked increase in rate of stretch with no increase of load.

Steel castings, on the contrary, do not show a constant cross-strain ratio. The amount of stretch under uniform increases of load is very irregular and the stress-strain curve is far from a straight line from its very beginning at the point of initial load. And so there is, of course, no one point where the proportionality of stress to strain shows a marked change, i. e., no true proportional elastic limit.*

Hence, for steel castings it is not feasible to specify the elastic limit and to require its determination by the usual stress-strain curve method. The alternative is to specify the yield point and to require a more accurate determination of it than is secured when the beam of the testing machine is used as an indicator. One satisfactory method of securing greater accuracy is to use an extensometer to detect the point of greatly increased rate of stretch. Another is the method of striking an arc on the chalked or smoked surface of the specimen and watching for the first visible widening of this arc. Both of these methods are quite workable and give a close indication of the actual yield point.

The usual determination of the proportional elastic limit, as has been noted, also actually gives a close measurement of the yield point so there is no difference in the physical property measured and little difference in the value obtained under the two different requirements (where applicable). But while there is no difference in final results there is a difference in the properties originally specified and in the method of test contemplated in the specifications. And it is worth while to point out this difference for it is highly desirable that both manufacturer and purchaser realize just what properties and characteristics of the steel it is the intention to establish under test and just what the properties are, which are actually determined in the prosecution of the test.

The fact that an elastic limit specification is not readily applicable to steel castings has been taken account of in some recently proposed revisions, which specify a minimum yield point instead of a minimum elastic limit, when the tensile strength specification is omitted.

Ductility Specifications.

The new manner of specifying the ductility requirements, i. e., in terms of the tensile strength or of the elastic limit or yield point is coming into more general use. The tensile strength is the more satisfactory to use for steel castings because it can be more exactly determined and because it shows a more uniform relation to the other properties. The new specifications state that the per cent of elongation and the per cent

*Lawford H. Fry, "Tensile Properties of Steel Castngs," Proc. A. S. T. M., June, 1922.

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of reduction shall be equal to certain constants divided by the tensile strength, with a fixed per cent of elongation and a fixed per cent of reduction required as a minimum for each type of steel. The intention is, seemingly, to take into account the inverse relation which exists between the tensile strength and hardness of steel on the one hand and its ductility on the other hand, and the change from the former method of specifying a definite percentage of elongation and of reduction for each class of steel regardless of strength, is very logical. But when we come to examine the percentages required as a fixed minimum we find, in some specifications, that they are set so high as to correspond to the ductility of the softest steel in each class.

The sliding scale set up by the formula thus becomes inoperative over almost its entire range, because the value obtained by its use is always less than the fixed minimum. In a few cases where the tensile strength is unusually low relative to the yield point, which is up to the requirement, the scale might operate. The result would be, of course, a higher ductility requirement for the steel in question than the fixed minimum.

The net result then is to raise the ductility requirements. This would not be objectionable in itself if it were the end sought and were thought necessary. But after recognizing the fact that for two steels of the same general class the one with the higher tensile strength and hardness will be less ductile than the one with the lower tensile strength and hardness, and this with no sacrifice of quality, it is illogical to turn about and say that the stronger steel must nevertheless show the ductility expected of the one of lower strength.

New Methods of Test.

Of late much more attention is being given to the strength of materials under repeated and reversed stresses and to methods of determining this property of resistance to fatigue.

Some very interesting data have been published covering the fatigue strength of ferrous metals in the rolled condition.* While cast steel probably has different fatigue properties than rolled steel, it is likely that some of the general facts established regarding the relation of fatigue strength to other properties will prove true for cast material also.

It was found that the ultimate tensile strength bears a closer relation to the fatigue strength (endurance limit) than does the elastic limit; that neither the ultimate tensile strength nor the elastic limit have a sufficiently close relation to the endurance limit to justify their use as an index of the latter; that of the tests more commonly used, the Brinell hardness test bears the closest relation to the endurance limit and gives the most promise of serving as an index of it.

The fact that the tensile strength shows a distinct relation to the endurance limit and that the elastic limit does not, may serve to modify the present estimation of the relative importance of these two properties. With regard to cast steel, this information is particularly pertinent because, as we have seen, cast steel has no true elastic limit, while its ultimate strength is a very definite property.

*H. F. Moore and J. B. Kommers, "An Investigation of the Fatigue of Metals," Bulletin 124, Engr. Experiment Station, University of Illinois.

Brinell Testing.

The use of the Brinell hardness test is steadily increasing in metallurgical testing because of its ease of execution and dependability and the significance of its results, especially when the action of certain material or heat-treated part, under the Brinell test, has been previously studied. For these reasons, in cases where the material is subject to 100 per cent test and inspection, the Brinell test is frequently specified by giving the limits of hardness desired. Now that some indication of the fatigue properties of the metal is also obtained by this test it will undoubtedly be employed to a still greater extent.

Brinell testing of steel castings has been done to a limited extent, largely for specific information as to hardness. The difficulty of applying the test to large pieces is an objection not easily overcome. It may be that the portable Brinell could be utilized for this purpose, though so far as the writer is aware, this adaptation of the Brinell test is not nearly so well standardized as is the regular method.

Another serious objection would be the influence of minor surface defects or non-uniformity on the Brineil tests. On the other hand we have the present method of judging the annealing of castings of various sections, by the visual examination of the fracture of an annealing lug with a section of ½ in., which it is readily admitted is a far from ideal method. In most cases where annealing lugs are used the inspection by means of their fracture is a 100 per cent operation and the Brinell test could be applied with no greater consumption of time.

With the larger use of heat treated castings which is surely coming, the Brinell test will undoubtedly be quite commonly specified.

TRUMBULL STEEL COMPANY TO ENLARGE PLANT

Plans of the Trumbull Steel Co., Warren, Ohio, provide for the installation at some future time of eight additional open hearth furnaces. The company now has a complement of seven open hearths, but its blooming mill and bar mill have sufficient capacity to roll the output of eight additional units. In recent years, the company has been gradually increasing its capacity, until it can now produce 40,000 tons of steel products per month, including billets, sheet bar, blue, black and galvanized sheets, galvanized and painted roofing, electric sheets, tin mill black, tin plate, hoops, bands and hot and cold-rolled strip steel.

It employs about 6,000 men, or nearly half the working population of Warren, and is self-contained. Its ore mines in Minnesota will take care of its present needs for 15 or 20 years. The Trumbull Coal Co., a subsidiary, operates coal mines in Greene county, Pennsylvania. The Trumbull-Cliffs Furnace Co., in which the Trumbull Steel Co. is a joint owner, operates the largest blast furnace in the Mahoning Valley, with a rating of 600 tons per day, but which can easily produce up to 700 tons daily under normal circumstances. The ore yard is 500 ft. long and has a capacity of 500,000 tons.

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New Development in Rolling Mill Drive

New Electric Drive for the Hot Strip Mill of the Trumbull Steel Company at Warren, Ohio, Described

By A. K. BUSHMAN
Power and Mining Engineering Dept., General Electric Co.

AN interesting electrical equipment representing a totally new development in rolling mill drive has just gone into operation on the new 14-in. continuous hot strip mill of the Trumbull Steel Mill.

The mill itself, which was built by the Morgan Construction Company of Worcester, Mass., consists of a roughing train, having four stands of horizontal rolls, an intermediate train with two stands, and a finishing train having four stands. The roughing stands are driven by a 600-volt, shunt wound, d.c. motor which will develop 1,250 hp. (50 deg. C.) at any speed between 175 and 350 rpm. through reducing gears. The intermediate stands are driven by a similar motor direct connected to stand No. 6 and through reduction gears to stand No. 5. The four stands of the finishing mill are each driven by individual 800-hp. motors of similar design, but different speeds, which are directly connected to the rolls.

The power to operate the whole mill is furnished by two synchronous motor generators, each consisting of a 2,300-kw., 600-volt, compound wound d.c. generator direct connected to a 3,300-kva., 2,200-volt, 60-cycle, 3-phase synchronous motor. The main shunt fields of the generators and d.c. motors are separately excited from a 250-volt d.c. circuit. The electrical equipment was built by the General Electric Company.

The control which makes this drive possible does not work on the principle of maintaining a given ratio between stands, but maintains constant any speed at which a motor is set entirely independent of other motors. It is evident that this system is much simpler and more readily set up than one depending on change gears and cone pulleys and since the speeds of the various motors are constant the ratio between them must also be constant.

On the shaft of each d.c. motor there is mounted a small alternating current generator, known as the pilot generator. The fields of these generators are connected to the exciter bus which is supplied by a small motor generator controlled by a voltage regulator which maintains constant excitation on the generators, therefore the delivered voltage of any one of them will be strictly a function of the speed of the d.c. motor to which it is connected. This voltage is used to actuate a voltage regulator that cuts resistance in and out of the d.c. motor field circuit. For instance, if the motor speed drops off for any reason, the voltage of the pilot generator, being reduced, will cause the regulator to cut resistance into the motor field, weakening it, and bringing up the speed. In case the motor overspeeds beyond its set limits, a reverse action takes place. The use of an anti-hunting winding on the regulator, which causes it to break its contacts without waiting for the motor to come up to speed, prevents any hunting on the part of the motor.

If the pilot generators were operating on open circuit their generated voltage would be exactly proportional to their speed, but in order to obtain a greater degree of sensitiveness the primary of a transformer is connected in series with the regulator coil and the secondary is loaded on a bank of condensers so that a large part of the excitation of the pilot generator is derived from the heavily leading power factor of the armature current. We, therefore, have four factors tending to give a change in voltage across the regulator coil with a change in speed. First, the direct effect on the voltage due to a change of speed; second, the effect on the armature current due to

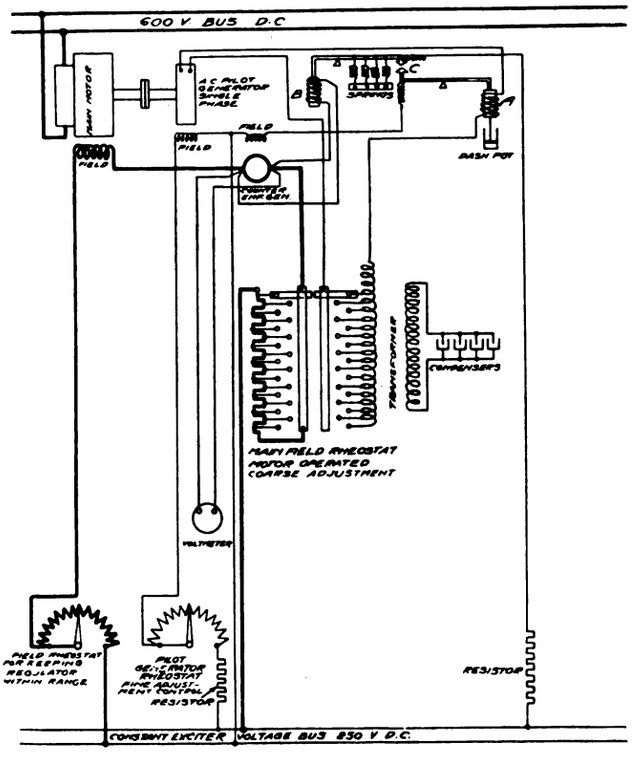

Fig. 1—Schematic diagram speed regulating control for d.c. motors.

a different frequency being impressed on the condensers; third, the effect of the armature current on the generator voltage; fourth, the effect of a change in speed on the power feacot of the armature current with a corresponding change in the voltage drop across the inductive transformer primary, this drop being negative for low leading power factors and positive for lagging power factor. These four effects are cumulative and cause a change in regulator coil voltage many times greater than the change in speed.

Adjustments of the speed on any individual motor are made from the pulpit of the mill, by means of three rheostats, one being motor driven. The latter changes the resistance in the motor fields and adjusts the regu-

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lator coil circuit simutaneously by changing taps on the primary of the transformer. These taps are so proportioned that the voltage impressed on the regulator is constant regardless of changes in motor speed caused by the motor operated field rheostat, thus making it unnecessary to make any adjustment of the regulator for different speed settings—in other words, the regulator holds the same pilot generator voltage whether the motor is operating at maximum or minimum speed. The second rheostat makes extremely small changes in the resistance of the pilot generator field, thus allowing the operator to make slight adjustments of the speed setting

factory before the order was placed and experience with the apparatus in actual production has completely fulfilled expectations. With the aid of the extremely accurate tachometers mounted on the pulpit benchboard the mill may be set up for a different product in a very few minutes and the first piece is put through at full speed. As many as 10 different sizes of strips have been rolled in one day.

The control is so simple and easy to operate that the regular operators experienced no difficulty in handling the equipment and on the second day of rolling without special instructions put the entire equipment into opera-

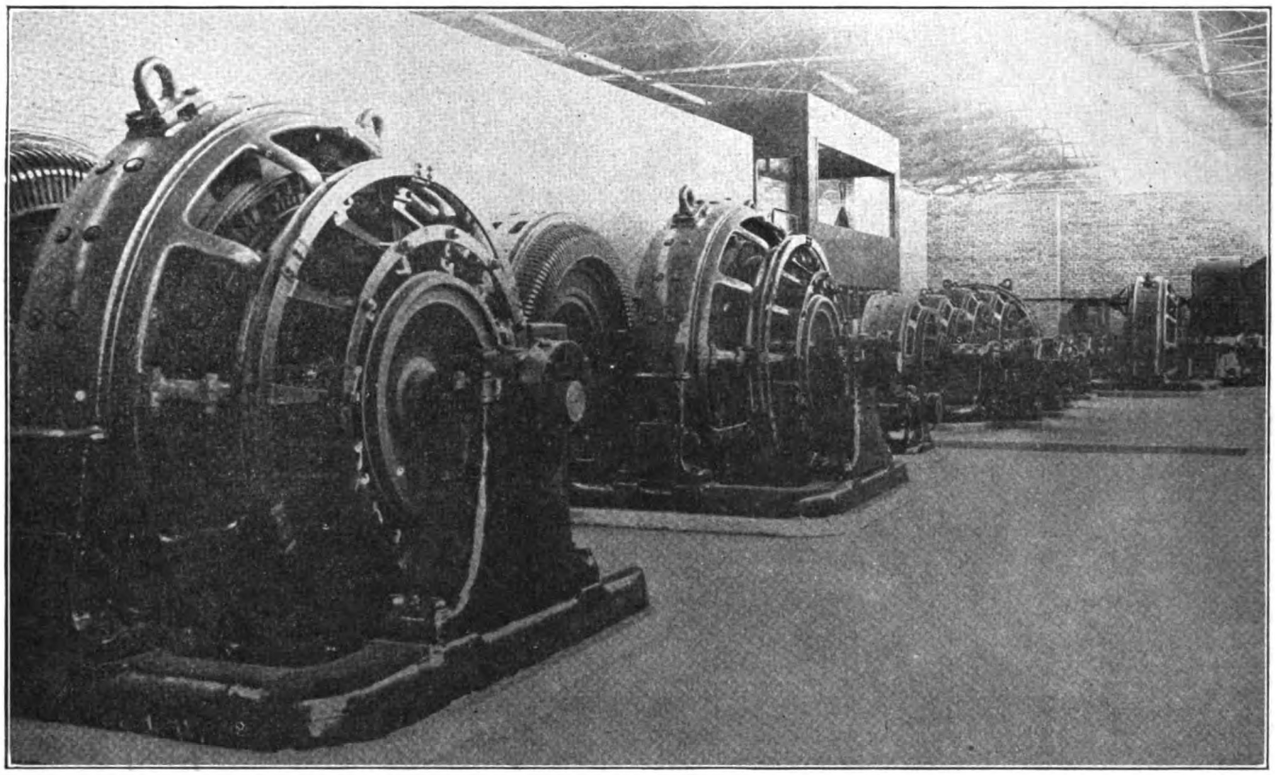

Fig. 2—Motor drive of new electrically driven hot strip mill, furnished by the General Electric Company at Trumbull Steel Company. The large machines in the foreground are motor generator sets. The mill drive is the group of machines in the background.

that may be desirable. The third makes small changes in the main motor field without a corresponding change in the regulator coil circuit and is used in connection with a voltmeter across the armature of the counter E.M.F. generator in the field circuit to form a "range finder" to correct for changes in line voltage and keep the regulator operating in the middle portion of its range.

Looking at the diagram it will be seen that the control system is very simple and involves standard equipment only with the single exception of the transformer in the pilot generator circuit which is one-half kva. in capacity and so rugged in construction as to practically eliminate the possibility of any trouble from this source. The regulators have but one vibrating contact and one relay contact which carries the field current of the counter E.M.F. generator which is less than a quarter of an ampere. Every effort has been made to insure continuity of operation and all delicate adjustments have been avoided.

This control will hold the motor speeds constant under changing load conditions and will not allow the speed ratio to vary enough to cause loops or to pull the strip was thoroughly demonstrated in preliminary tests at the

tion before the factory men arrived at the plant. In fact, the first day of operation, in spite of the numerous delays for minor adjustments, such as are always necessary when breaking in new machinery, the mill produced 130 tons of strip for shipment. The mill has produced 235 tons in a single turn and this is not believed to be its maximum capacity.

The continuous mill has been very highly developed by the manufacturers so that some mills produce as high as 97 per cent of their theoretical capacity over long periods of time. It is evident that very little, if any, improvement may be expected in this direction and attention has therefore been turned to increasing the flexibility of the apparatus.

Previous to this installation described, Morgan continuous strip mills have been driven from two or more sources of power through gears on the roughing and intermediate stands and through belts and pulleys on the finishing stands. In order to prevent loops or stretching of the metal the peripheral speed of the rolls of each successive stand must increase in proportion to the elongation of the metal, but since the diameter and rpm. of the

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rolls is fixed the reduction for each stand is also fixed as long as the initial size of the billet is unchanged. This makes the mill very inflexible and difficult to set up and to obtain some products it is necessary to start with a special size billet or even to change the rolls in some stands.

Obviously, the ideal continuous mill would have individual drive for each stand, at least on the finishing end, thus allowing the use of any desirable combination of speed and draft. This arrangement has been used for many years on tandem cold strip mills when the rolling

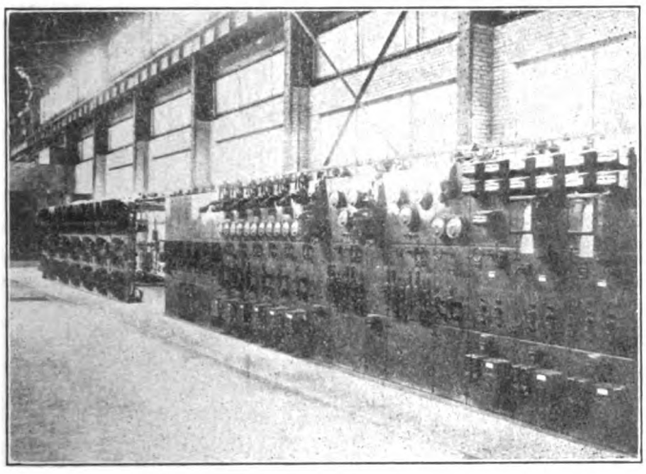

Fig. 3—Switchboard for strip mill drive at Trumbull Steel Company.

speeds are low and the distance between stands is comparatively large so that a small change in the speed ratio of any two stands does not quickly stretch the metal or form a loop too large to handle. A high speed hot mill such as that at Trumbull, however, finishes at speeds around 2,000 feet per minute and the distance between stands is but eight or nine feet, therefore the speed ratio between stands must be maintained with an accuracy very closely approximating that of gearing. This has been successfully accomplished by means of simple and rugged apparatus.

AMERICAN ELECTRICAL SOCIETY TO HOLD MEETING IN MONTREAL

Final arrangements for the forty-second general meeting of the American Electrochemical Society, at Montreal, Que., are being made which will make this meeting one of the best in the history of the society.

The meeting will be opened by President Schluederberg on Thursday morning, September 25, and the technical program will proceed with the presentation and discussion of papers on electrolysis and electroplating. The recently organized Division of Electrodeposition, G. B. Hogaboom, chairman; William Blum, secretary, will be well represented and take active part in the discussion of these papers.

One of the papers of the Thursday morning session will deal with the physical properties of electrolytic iron—a product which is being turned out commercially, contrary to all predictions of 10 years ago. There will also be papers on zinc, brass, and other electrodeposited metals.

On Thursday afternoon and Friday morning a very interesting symposium on "Industrial Heating" will be in progress. The Electrothermic Division, Bradley Stoughton, chairman; Colin G. Fink, secretary, which held a most successful symposium on "Electric Cast Iron" at the Baltimore meeting, in April last, will again be in charge. Twelve papers especially prepared for this session and dwelling on industrial heating in electric furnaces, other than fusion and melting furnaces, will be placed open to discussion.

There will be papers on:

a. "History of Industrial Heating."

b. "Principles of Design of Furnaces."

c. "Comparison of Fuel Costs in Different Types of Electric Furnaces, and With Combustion Furnaces." (In this connection electric energy would be estimated as a "fuel cost.")

d. "Resistor Materials."

e. "Specific Heats."

f. "Electric Conductivity of Insulating Materials at Industrial Furnace Temperatures."

g. "Heat Emissivity."

h. "Heat Transfer."

There will be an excursion to Shawinigan Falls, affording members a rare opportunity to inspect the various industrial plants of one of the most progressive centers on the continent. It is planned to have a special train for this all-day trip from Montreal.

A popular lecture on "The Progress in Physical Science" is scheduled for Thursday evening. Section Q will be in charge of an old-fashioned smoker on Friday evening.

The headquarters for this meeting will be the Hotel Windsor. Members and guests are urged to make their hotel reservations immediately.

M'KUNE-EGLER-DANFORTH OPEN HEARTH SYSTEMS

The Miami Metals Company, Arthur G. McKee & Company and Blair Engineering Company have announced that they have assigned the Egler, McKune and Danforth patents, together with all other patents and patent applications which they own, which relate to combustion in a regenerative furnace, to the Union Trust Company of Cleveland, Ohio, trustee, for the Open Hearth Combustion System and that the trustee is empowered to grant licenses under these patents.

This announcement is of great interest to the trade. No invention in recent years in the steel industry has attracted more favorable comment than that of the blow torch open hearth furnace.

Inasmuch as the McKune and Egler systems obtain practically the same results, it appears as if the best interests of the steel trade will be furthered by a consolidation such as has been effected. As a result of this consolidation of the interests, it is now possible for a steel plant to build a furnace incorporating the best features of both systems without being liable to suits for patent infringements.

The Blaw-Knox Company of Pittsburgh have been appointed general agents for the exclusive sale and manufacture of all equipment covered by these patents. With their plant facilities, special engineering and service departments composed of experts in open hearth design and operation, they are especially qualified for the handling of this department.

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Gas Burners With High Efficiency

Feature of Burner Design by Muller Is That It Assumes a Very Intimate Mixture of Gas and Air, And That All Gas Pressure Fluctuations Are Fully Compensated for By the Burner.

By A. THAU
Coke Works Superintendent, Oxelösund in Sweden

IN his lecture before the American Iron and Steel Institute in the earlier part of last year, Walter Flanagan referred to the methods applied on American works to burn blast furnace, producer, or coke oven gas. On European works and particularly in Germany, where in accordance with the peace treaty huge quantities of fuel have to be supplied to the former enemy countries, so that an acute scarcity of fuel is felt almost everywhere, heat economy has become a subject of extreme importance and is being developed upon quite scientific lines to make use of every source of heat and to exercise the utmost economy with the available fuels. That applies in the first instance to the efficient burning of industrial gases to which the writer has also paid a good deal of attention, and giving in this article an outline of his experience with a particular class of burner which, after trying almost every available other type on the market, was eventually adopted by him. It should be emphasized in the beginning that the writer is neither directly nor indirectly interested in the construction or manufacture of the burner and advances his experience solely for the benefit of his fellow engineers abroad.

The burner of which Fig. 1 gives a rough sketch was designed by Muller, a blast furnace engineer, who during the war was faced with the serious problem to make the available quantities of blast furnace gas go round, and who, after studying closely the phenomena of combustion on the mouth of a gas burner came to the conclusion that even in the best burner design available at that time, there was great room for improvement. Therefore in 1916 introduced a burner of his own design which by 1919 was so perfected as to appear successfully on the market.

It is a comparatively simple matter to design a burner which for all intents and purposes is nothing but an injector with gas as the primer pulling in the proper amount of air theoretically required for the complete combustion of the gas. We know, however, now that it does not by any means suffice the requirements of ideal combustion to get the theoretically required amount of air or even a small excess into the burner, especially as long as the gas pressure remains fairly constant. The main problem is to get an intimate mixture between gas and air avoiding separate gas and air zones leaving the burner mouth.

In a Lancashire gas fired boiler, for instance, it has been observed that the burner drew in an excess of air over that required theoretically for complete combustion, still there was carbon monoxide present in the flue gases. The cause for this was traced back to the fact that the velocity by which gas and air passed straight through the boiler flues was so great that the gas and air zones had not sufficient time to form an intimate mixture within the boiler flues. The combustion extended right down to the chimney base accounting for the presence of CO and a great waste of heat escaping with the chimney gases. In checking the chimney draught to reduce the velocity of the combustible mixture within the boiler flues, the burner drew in less air with the result that not sufficient air was available for combustion. Therefore the temperature of the chimney gases dropped, but their contents of CO increased again. The only remedy was to reduce the gas feed to the burner so that only a very poor efficiency could be obtained.

The writer tried another much advertised type of burner with coke oven gas on a Lancashire boiler. In this burner the gas entered in the form of an annular ring all round inside the cylindrical body. The air for combustion was drawn in by a very large central nozzle fixed to the outer end of the body. The combustion was quite normal, but by a sudden unnoticed increase of gas pressure the annular gas stream by its increased volume tapered the air space down so much, that eventually no air at all was drawn in. The gas extinguished, traveled unburnt through the boiler flues and ignited in the chimney flue causing a disastrous explosion in which the writer nearly lost his life.

From the foregoing remarks the plain conclusion must be drawn that the ideal burner must be so designed as to assure the formation of a very intimate mixture of gas and air on its heating way, and that the burner must be effectively able to cope with the variations of gas pressure which cannot be avoided in the gas circuits of large works. The length which the gas flame is to have on its way of combustion is a matter of selecting the proper size of burner, able to deal with the corresponding volumes of gas and air.

The gas burner by Muller serves these requirements better than any of the many types I have had under my care for many years. Its particular feature rests with the fact, as will be seen from the sketch in Fig. 1 that by means of a number of fixed, peculiarly twisted blades, the gas entering the burner is forced to a rotating cork-screw-like motion on its way of combustion. The burner is slightly differently designed for the purposes for which it may be applied and for different kinds of gases used for heating. For use in Lancashire or Cornish boilers it is provided with channels bent outwards in the direction of the burner mouth so that the flame is thrown by centrifugal force on to the inner walls of the boiler tubes, and as the cork-screw-like rotation is maintained right through the whole length of the tubes, a very intimate contact between flame and tube plates is assured. The burner consists of a short cylindrical body, and if the flame is to be centrifugally spread out like in the case of Lancashire or Cornish boilers, the burner body increases in diameter towards its mouth, while in cases where it

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is desirable to retain the flame more on a central axis, like for instance, in blast furnace stoves, the burner body is best tapered towards its mouth.

The front portion of the burner is divided by fixed and twisted plates into a number of radially distributed compartments, of which to everyone connected to the gas delivery, the two on each side of it are open to the atmosphere serving as air inlets. By the peculiar twist of the blades forming the gas and air chambers, the partitions form together a screw with different pitch for gas and air so that the free area left is differently proportioned in accordance with the heating value of the gas. In front of the housing holding the gas and air chambers is a distributing space for the gas, connected by means of a valve to the gas supply main. The air for combustion is automatically drawn in by the gas. The burner differs from nearly all others in that it is not at all attempted to force the gas and air into an intimate mixture inside the burner body, but upon leaving the burner mouth, gas and air are divided into a number of fine streams being distributed over the periphery in proper rotation. The way by which gas and air leave this burner and enter for instance a boiler tube can best be explained by comparing it with rope making. Like in rope making, the single threads are issued over a distributing ring, and by turning round all the time, for a thick rope which keeps also turning all the time, so shoot from this burner thin streams of air and gas through the annular burner mouth, forming inside the boiler tube a large hollow rotating column like a hollow rope. It is very interesting to observe this rotating combustion by throwing a small fairly hard pressed ball of paper into the burner, and its spiral passage through the whole length of the tube can be very plainly observed. To attain such a way of combustion was a great step forward, since with most other burners in which the flame burns simply on a horizontal axis into the tubes, an intimate contact by which every single spot of the inner tube plate is covered by the flame cannot be attained without a great excess of heat and consequent waste in the chimney flue.

While in the case of blast furnace gas the required mixture for combustion is about 1:1, with coke oven gas the proportion is about 5:1, so that in the latter case the number of chambers dividing gas and air into single streams is largely increased, compared with the former to ensure an intimate mixture and complete combustion. The whole burner is made of cast iron to ensure a tight separation between gas and air distributing chambers since leaks would cause a preignition or a back firing and would disturb the proper operation. For the same reason must the burner be tightly fixed to the boiler face to prevent any air from entering the combustion flue except through the proper channels in the burner itself.

In the case of blast furnace stoves, the burner is fixed at the base projecting into the combustion chamber and such a special design is applied that the combustion products rise in the central shaft of the Cowper. This precaution is being taken as otherwise if the flames were allowed to impinge upon the brick work inside the stove, the walls would suffer too much. This effect is, as already mentioned, being reached by giving the burner body a certain taper towards its mouth contrary to the shape applied to Lancashire or Cornish boilers.

To illustrate the operation of the burner a few average figures are added from the daily returns of the works referring to Lancashire boilers heated by blast furnace gas.

Calorific value of gas:
1006 Cal./cbm., 113 Btu./cbft.

Analysis of gas:

CO_2	12.2%
CO	28.0%
Cn Hn	0.4%
H_2	3.6%
O_2	0.0%
N_2	55.8%
	100.00

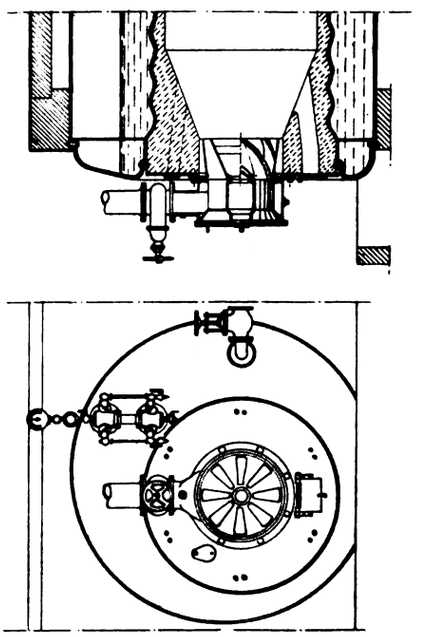

Fig. 1—Diagram of the burner.

Temperature of gas	12 deg. C.	54 deg. F.
Gas pressure in main line	150 mm.	6" WG.
Gas pressure between valve and burner	80-100 mm.	3-4" WG.
Draught on back end of boiler tubes	22-25 mm.	⅞-1" WG.
Draught in chimney flue	29 mm.	1⅛" WG.
Temperature on back end of boiler tubes	540 deg. C.	1004 deg. F.
Temperature of chimney gases	180 deg. C.	356 deg. F.

Analysis of combustion products:

CO_2	25.0%
O_2	traces
CO	nil

Steam raised per hour—29-31 kg. per m² heating surface = 5.945-6.355 lb. per square foot heating surface.

Steam pressure in boiler—6-7 atmospheres 88.2-102.9 lb. per square inch.

Feed water temperature—56 deg. C., 133 deg. F.

Possible increase over normal capacity—40%.

While with the former burners which were replaced by those of Muller the gas consumption was 1.1-1.2 cbm. per kg, steam = 17.61-1921 cbft. per lb. steam. This figure was improved upon by the new burner to 0.844-0.881 cbm. gas per 1 kg. steam = 13.51-14.15 cbft. of gas per lb. steam, being equal to a saving of 15-17 per cent.

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The heat developed by this burner is much more intense compared with the formerly adopted types, and while formerly 650-750 deg. C. = 1202-1382 deg. F. were reached, an average of 800 deg. C. = 1472 deg. F. can now be maintained without special efforts.

The increase of temperature makes itself favorably felt in the heating of blast furnace stoves. By driving the stack moderately it can be assumed that one Cowper is two hours under wind and two stoves heating for six hours. This mode of working was considerably improved upon by equipping the stoves with Muller burners with the result that by the quicker heating instead of three or two Cowpers being heated only two or one are required. By these means the work of the man in charge was greatly reduced. In case of new plants it may even be possible to reduce the number of stoves by one and on plants with existing Cowpers, one stove may be set apart as a stand by.

By reducing the number of stoves and shortening the way of the hot blast mains a further saving of heat is effected by reducing the surface area losing heat by radiation depending of course greatly upon local conditions.

Since 1919, when the trials with the first designs were concluded under all possible conditions, over 300 burners of this type have been introduced for all purposes where industrial gases are used for heating, viz: Boilers, stoves, reheating furnaces, forges, also for the heating up of steel converters and ladles and for industrial furnaces of any kind.

These burners have remarkable properties to cope with even the most severe fluctuations of gas pressure. Back firing is practically unknown. Two pressure charts, taken from Lancashire boilers, were recently compared. One of the boilers was heated by coke oven gas, while the other was heated by blast furnace gas. Comparing the two charts, it was found that the contents of CO_2 in the flue gases remain almost constant showing that the great pressure fluctuations as recorded on the gas pressure chart are fully compensated by the burner.

With the coke oven gas the CO_2 contents averaged about 9.5 per cent with the blast furnace gas 22.5 per cent. A boiler efficiency of 85-87 per cent is being continuously maintained as long as the boilers are fairly clean and in case of blast furnace gas when the contents of dust are not too high.

AMERICAN ELECTROCHEMICAL SOCIETY'S FALL MEETING

Final arrangements for the forty-second general meeting ofthe American Electrochemical Society, at Montreal, Que., September 21, 22 and 23, are being made. The technical program for Thursday, September 21, will include papers on electrolysis and electroplating. The recently organized division on electrodeposition (G. B. Hogaboom, chairman; William Blum, secretary,) will be well represented and take active part in the discussion. One of the papers will deal with the physical proprties of electrolytic iron. There will also be papers on zinc, brass and other electro deposited metals.

On Thursday afternoon and Friday morning a symposium on "Industrial Heating" will be in progress. The electrothermic division (Bradley Stoughton, chairman; Colin G. Fink, secretary,) which held a successful symposium on "Electric Cast Iron" at the Baltimore meeting, in April, will again be in charge. Twelve papers especially prepared for this session and dwelling on industrial heating in electric furnaces, will cover history of industrial heating; principles of design of furnaces; comparison of fuel costs in different types of electric furnaces, and with combustion furnaces (in this connection, electric energy would be estimated as a "fuel cost"); resister materials; specific heats; electric conductivity of isulating materials at industrial furnace temperatures; heat emissivity, and heat transfer.

There will be an excursion to Shawinigan Falls to inspect the various industrial plants of one of the most interesting centers on the continent. A popular lecture on the "Progress in Physical Science" is scheduled for Thursday evening. Section Q will be in charge of an old-fashioned smoker on Friday evening. The headquarters for this meeting will be the Hotel Windsor.

PROFESSOR STUMPF ENTERTAINED

Prof. Johann Stumpf, Berlin, Germany, inventor of the Unaflow engine, who is making a tour of the United States, was the guest of Manager Neil C. Lamont, Laidlaw Works of the Worthington Pump & Machinery Corporation, Cincinnati, on August 22. Mr. Lamont had invited the members of the American Society of Mechanical Engineers, Cincinnati branch, to meet at the plant for the purpose of inspecting the latest type of engines and compressors and also to hear Professor Stumpf deliver an address on the latest developments in the Unaflow engine. Following an inspection of the shops and a number of engines in operation, dinner was served in the dining room at the plant, at which, in addition to the visiting engineers, officials and shop foremen of the company were present.

EXPLOSION WHEN GAS IS TURNED OFF

Under the above heading, a paper was read before the Societe de l'Industrie du Gas en France by M. L. Causse.

Comment is made upon the fact that while at times no explosion takes place, at other times it is considerably retarded, and in general, varies in intensity.

Explosions never occur where there is a pre-admixture of air, and the latter should enter, therefore, while the residual gas is leaving the apparatus. The residual gas leaves the apparatus because it is lighter than air, and, in addition, because it is warm.

Tests have been made with a view to retarding the explosion, whereby the phenomenon could be brought more readily under experimental observation. An illustration is given of an apparatus which has been designed whereby it is possible to ascertain what happens prior to the explosion, what determines the moment of explosion, and also what determines the greater or smaller force of the explosion.

Minute details are given relative to what happens during the first period, the explosion itself, the causes of delay and the force of the explosion. It is shown that this latter is a complicated phenomenon which brings into play all the characteristic properties of a gas and enables many incidental problems to be worked out, particularly with the aid of self-registering contrivances, and in this respect reference is made to an apparatus which has been devised by the author, based on the principle of automatic recording of the time interval which elapses before the explosion takes place after the gas is shut off.

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A Study of Valves For Furnaces

Operating Difficulties and Problems Which Result from the Design of Reversing Valves for Regenerative Furnaces.

By HAAKON HELLAN

PRODUCER gas is now pretty well recognized as the most satisfactory fuel for heating furnaces and open hearth furnaces. The furnace men like it for its smooth and even heat, and it is not by far so dangerous as the richer gases, such as by-product and natural gas. With the elimination of natural gas for industrial purposes, the producer gas is bound to find a more extensive use than at the present. Although it has been in use for some time, there are still many problems in connection with it that are yet little understood.

Great improvements in arrangement of flues have been made in the last few years by engineers who have specialized in this line, but the majority of the steel plant engineers have not kept posted on the progress made, and a good many troubles from dust collection, tar, and poor gas could probably have been avoided if the problem was tackled with the right understanding.

The regenerative method for preheating gas and air enables us to obtain temperatures in the furnaces sufficiently high for almost all purposes. In a furnace plant lay-out the furnaces with regenerators are generally located in a building by themselves, and the gas producers are housed in a separate building parallel to the furnace building. These units are connected by flues both over and under ground which conduct gas and air to the furnace and which dispose of the combustion gases from the process. Valves and dampers are used to control the flow of these gases. The whole flue lay-out depends upon the kind of valves that are employed, as does also the efficiency of the furnace. It is therefore of utmost importance to use valves that will satisfy their purpose without any detriment to the operation. We must distinguish between shut-off valves, regulating valves and reversing valves.

Shut-off valves on the gas line are used to close off some part of the flue system from the main and are used rarely. Their principal uses are in case of trouble or when the furnace goes down and is put on. A horizontal sand damper used to be the most common contrivance for this purpose, but a cast iron mushroom valve (Fig. 1) is more easily operated and can be conveniently arranged. Gate valves are very common for shutting off producers to the gas main, but are also used where the valve is wanted in a horizontal run. The valves are kept tight against the seat by keys, which have to be tightened and released every time the valves are used.

To regulate the gas and air a butterfly valve, a mushroom valve or a damper can be used. Butterfly valves are common for overhead gas flues. When the mushroom type is used we can get along with the same valve for both shutting off and to regulate, but it must be made to withstand the excess heat. Dampers are generally used to regulate areas of underground flues and are provided also for control of waste gases from the furnace and to regulate the stack draft.

When the checkers in the regenerative chambers have given up enough heat to become noticeable on the furnace temperature the direction of the gases is re-reversed.

The angle valve (Fig. 1) as it is used for shut-off valve on the gas main and burn-out valve to the stack has a cast iron mushroom valve that seats itself on an iron ring. It is often necessary to sand these valves to prevent leakage, and the sand is thrown in through a door on the side of the valve box. Two such valves (Fig. 2), both connected with the furnace flue and alternatingly opened, was the logical step towards reversing valves. The air valve (Fig. 3) is of a similar construction, only the intake is at the top of the valve box, and the opening is regulated by varying the lift. The gas valves did not stand up in the heat, and before they were used long the valves and stems were made hollow and watercooled, as in Fig. 4. They also proved difficult to keep tight, and an annular water trough was provided to furnish the seal in connection with a depending edge on the valve, as shown in Fig. 5. In some cases the valve falls down on the edge of the bottom pan and rests on it when closed, but it is better practice to limit the stroke, so that the valve seals properly into water without touching the pan.

The Knox reversing valve system, which is being used quite extensively, consists of mushroom valves in connection with inclined dampers which close and open for the waste gases to the stack. The gas valve, both dampers and the seats are watercooled. Gas is admitted directly from the gas main without going underground, and the waste gases are delivered directly into the stack flue without compelling them to go through the valve. The valves are shown in Figs. 6 and 7. Two gas valves and two air valves are needed for one furnace, and each valve has its damper. The valves and dampers operate with a few seconds interval, and about 30 seconds are required for a complete reversal. This interrupts to some extent the operation of the furnace and the process. The air valve area is regulated from a stand above.

The mushroom valves in original or improved form always required much room, as every valve had three ports and there were always four valves required. A great saving of space was affected by arranging the gas and air valve boxes over their respective boxes for stack valves, as shown in Figs. 8 and 9. This permitted the gas to enter from above, directly from the gas main, an advantage that eliminates a lot of trouble from soot collection in an underground pocket. The water enters the valve stem at the top through a flexible hose, is then conducted through a small pipe inside the valve stem down to the bottom flange, from where it rises and overflows through another small pipe into the open valve. From the valve the water flows into the bottom pan through a notch in the outer edge, or some valves. Some valves have an elaborate contrivance of telescoping pipe sections to conduct the water into the

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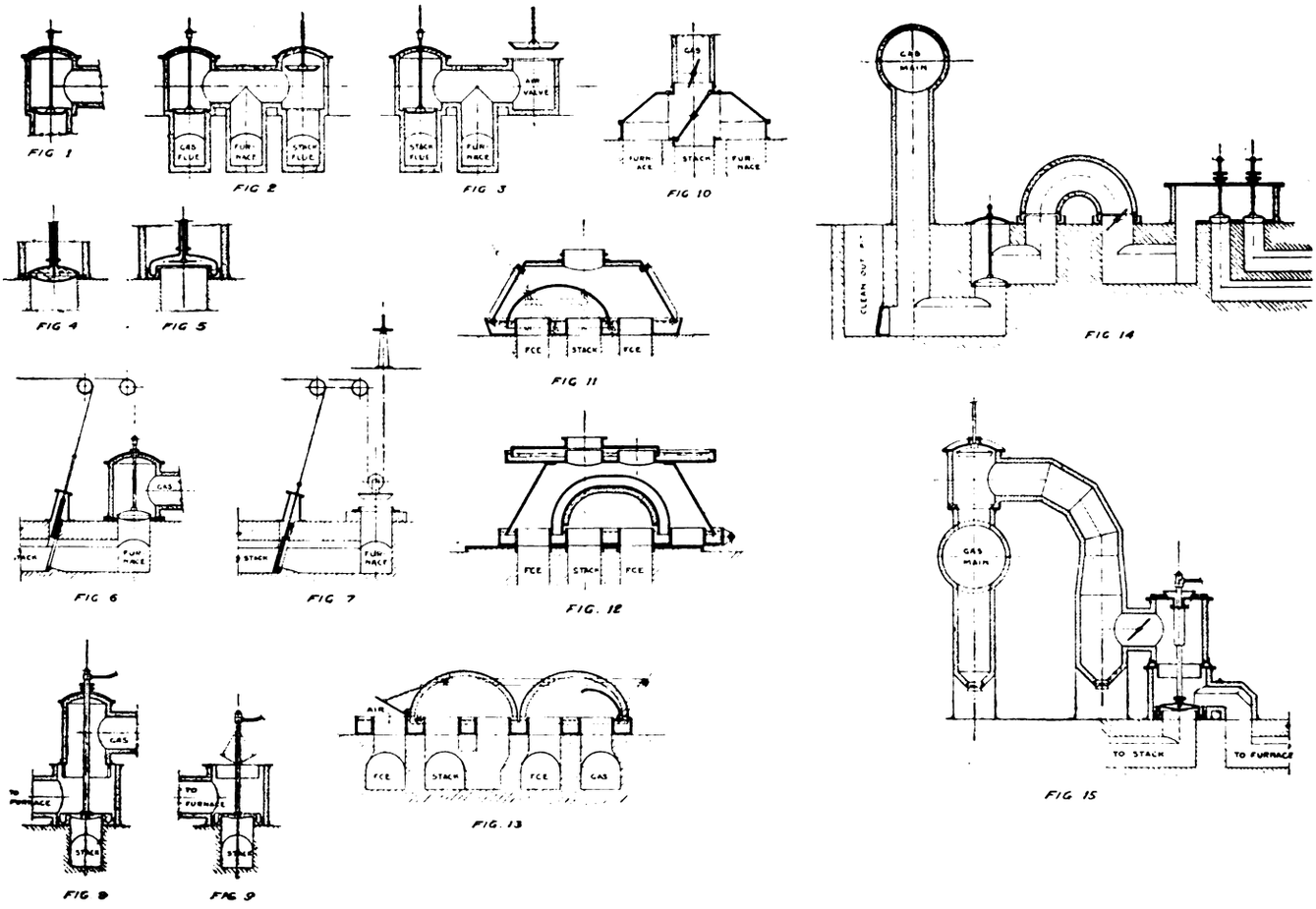
bottom pan. In its top position the gas valve seals off to the main by a watercooled diaphragm. The air valve is closed to the atmosphere in a similar way, but the diaphragm in this case is made of just one plate, no water cooling being necessary. The valve area is regulated by two half-circular plates hinged on the diagonal. The other great advantage these valves have over the three port mushroom valves is their simple arrangement of underground flues. (See diagram, Fig. 16.) If the valves did not possess one very objectionable feature they would doubtless have become more generally used. Whenever gas is brought in contact with open water, it cools off and absorbs the moisture, which is carried along to the furnace as a burden. Water is also easily splashed over into ports and flues, from where it has to be evaporated by the waste gases at the expense of draft. Besides, it does a lot of damage to the brickwork.

From another type is developed an entirely different group of reversing valves. The original "butterfly" valve, or Siemens valve, is shown in Fig. 10. It consists simply of a cast iron plate rocked back and forth when reversing and fitted against seats on the cast iron casing. The valve is extremely simple to install and operate, as well as low in first cost. But there is often considerable trouble due to warping of the valve occasioned by hot gases on one side and comparatively cool gases on the other. Attempts have been made to overcome this by watercooling both valve and casing, but without great success. There is also at times leakage at the seat, due to the deposit of soot and tar, which prevents the valve from closing tightly. Another difficulty with this valve was the leakge around the edges of the casing. Air was drawn into the gas flues, causing unexpected explosions in the flues and the furnace, and the valve casing suffered and was sometimes burnt up in a week. It was necessary to have a supply of castings on hand at all times. Still the valves are being used for both gas and air, the air valve having an adjustable mushroom valve to regulate the opening at the top.

The Forter valve substituted the butterfly with a moveable hood and swung it by one pair of rocker arms from one position to another. An improvement of this valve is the Wellman-Seaver-Morgan valve, shown in Fig. 11. The hood is here carried by two pairs of rockerarms, but arranged on the outside of the casing and thus protected from the hot gas.

A valve that is the same in principle, but operates by moving both the hood, pan and the casing on an iron seat, is the Schild valve (Fig. 12).

All these valves receive the gas at the top and require a very simple flue lay-out (Fig. 18). A recent valve on somewhat the same principle is the Isley valve (Fig, 13). It has two brick-lined hoods, connected and operated by a system of parallel levers. Two valves are required for one furnace. The one in Fig. 13 is open for gas and air to one side of the furnace, while the other connects the furnace flues to the stack. The valves require more space than any other. The gas has to be brought underground to the valve and there is the same



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difficulty with water as mentioned before. A diagram of the flue lay-out is shown in Fig. 19.

A type of reversing valve alone is the Blair valve. Its main feature is the refractory lined bent tube, which has one end always connected with the furnace and the other alternatingly connected to the underground gas flue or to the stack flue. There are three valves needed for one furnace, two for gas and one for air. In the case of the air valve the tube is used to conduct the waste gases from the air regenerators to the stack, while the uncovered port is the air valve, which is regulated by a butterfly valve. A diagram of the flue lay-out is shown in Fig 17, and Fig. 14 is a cross section of gas valves and flues in connection with regulating valves for a pit furnace. The gas is conducted through a vertical leg to an underground flue, where it can be shut off and opened by the mushroom valve at will. Before the tube is removed the valve is closed, and very little gas is lost. The tube is operated on a track by a motor or a hydraulic cylinder. The base casting

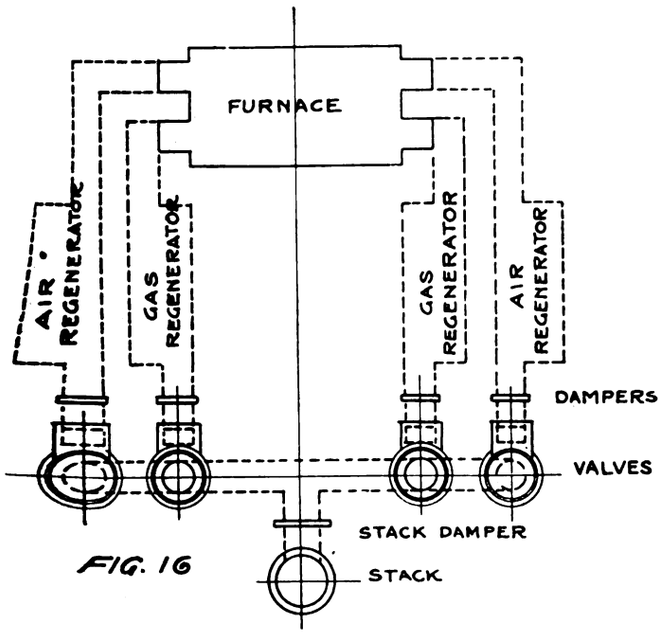

FIG. 16

is watercooled and the ends of the tubes make a perfect seal into the water, when in position. The section shows plainly the expensive underground flue arrangement; and the added cost of keeping the flues clean and maintaining the brickwork gives this valve a distinct disadvantage, as compared with other valves of recent make. Another feature is the location of the gas chambers on the outside of the air chambers, an arrangement which leads to greater radiation losses.

The reversing valves just described comprise the types that are now quite generally used. We have noted the good points and disadvantages of them all and are able to judge what is desirable and what should be avoided in such valves. Some people are in favor of one type and have a prejudice against another, although quite often the principle of the valve is not so much at fault as the circumstances under which they are used. The reversing mechanism for mushroom valves is very often designed with an erroneous object in view, and the valves are blamed for troubles arising from this. Some other types have the valves operated in pairs, other valves are independently operated and counterweighted. Some take longer time to reverse than others. One difficulty they all have tried to eliminate is the explosions in the flues due to the gas and air mixing on their way to the stack after a reversal. Another trouble closely related to this is the feature of the gas being short circuited to the stack during the short period of the reversal. This latter point is stressed a good deal by some manufacturers and used as an argument for their valves, which have been built to meet this trouble. When we consider that the re-

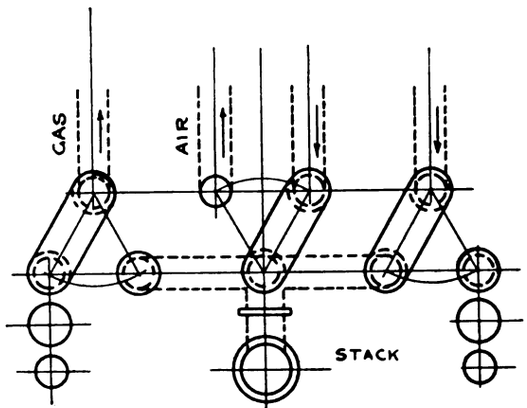

FIG. 17

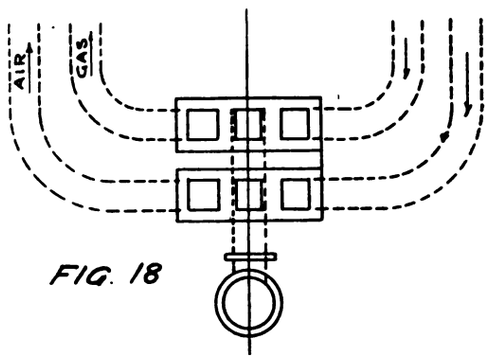

FIG. 18

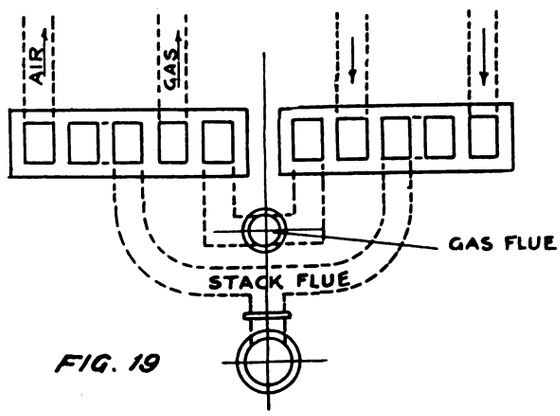

FIG. 19

versal of an individual valve hardly takes more than one or two seconds, and during that time is only partly open, very little gas can be lost due to this source as compared with all the gas trapped in the checker chamber and flues, and which has to be driven out through the stack. Let us suppose we have a 36-in. gas valve for a 70-ton open hearth furnace connected to two gas producers, each gasifying 3,000 lbs. of coal per hour.

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The amount of gas produced per hour = 2 × 3,000 × 60 = 360,000 cu. ft. per hour, or 100 cu. ft. per second. Area of 3-ft. valve = 7 sq. ft. Velocity of gas = 100/7 = 14.3 ft. per sec. It takes about one second to reverse the valve and in that time we can assume it to be half open at an average. The loss of gas will be = 14.3 × 7 × ½ = 50 cu. ft. per reversal, or for four reversals per hour = 50 × 4 = 200 cu. ft. per hour, In a year of 300 days' operation this loss represents 200 × 24 × 300 = 1,440,000 cu. ft.—1 ton of coal @ 2,000 lbs. = 120,000 cu. ft. of gas. The loss of gas due to this source will then become equivalent to:

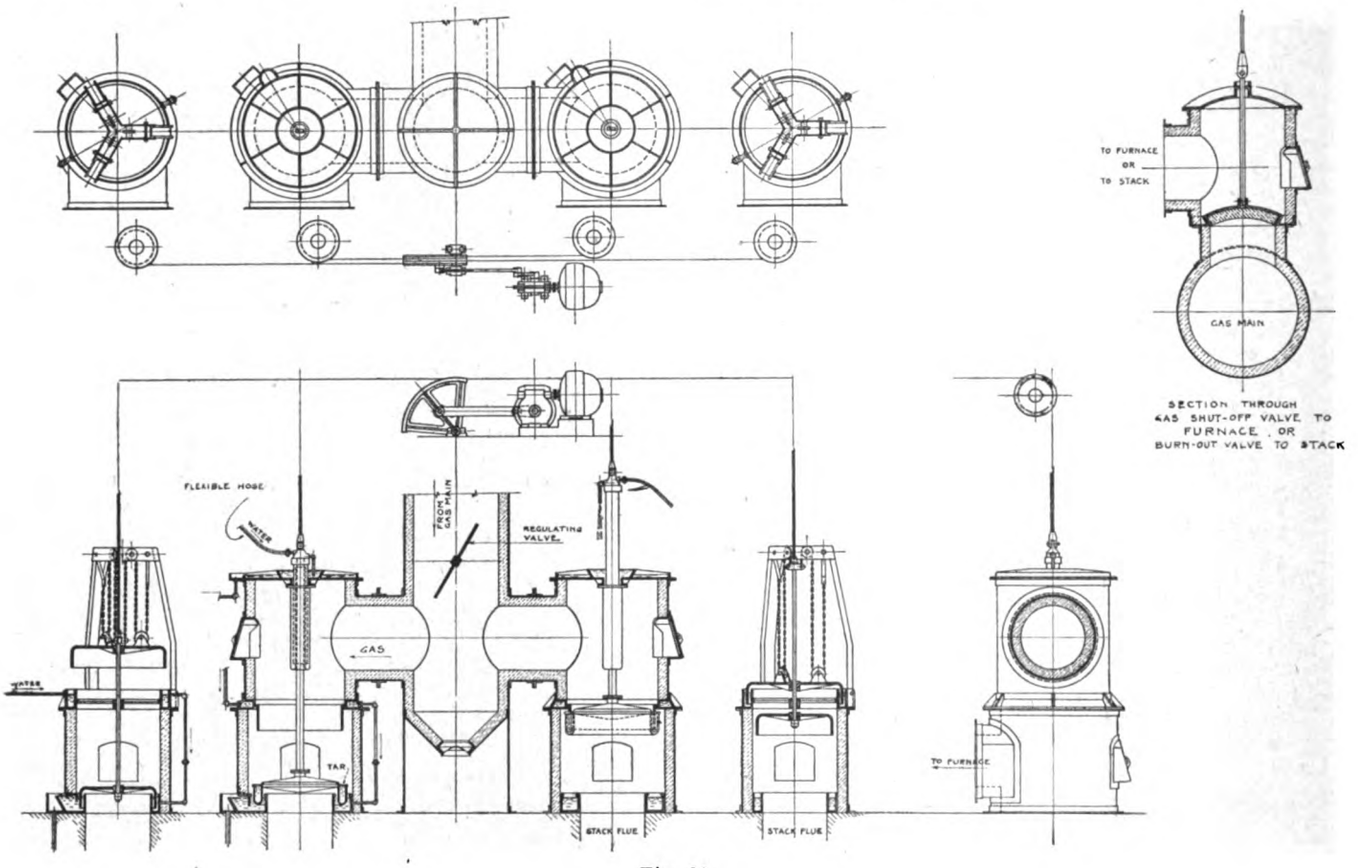

Fig. 20.

$$\frac{1,440,000}{120,000} = 12 \text{ tons of coal per year.}$$

At the same time the loss of gas in the checker chambers and flues can be computed for a chamber of 2,000 cu. ft., and the loss would represent:

$$\frac{2,000 \times 4 \times 24 \times 300}{120,000} = 480 \text{ tons of coal per year,}$$

which would be a considerable item if the plant has many large furnaces.

An explosive mixture and a spark or a sufficiently high temperature are required to cause an explosion. Assuming that we always get an explosive mixture, a spark can be carried as a glowing soot-particle in the gas at any time, and this danger is no less if gas and air valves were reversed with a few seconds interval than if they were reversed at the same time. Regarding the danger of explosion due to a high temperature of the mixture, we find this condition, that the gas and air just entered the valves on the way to the furnace both are at their lowest temperature, and the sooner they are brought together the lower the temperature, and the less the danger from explosion. By quickly and simultaneously reversing both gas and air valves, we would mix cold air and unregenerated gas. It is therefore quite obvious that quick acting valves all operating together is the most logical solution of the problem. It must also be evident that to close the valves on the main (gas flue) before changing the reversing valves is entirely unnecessary and does not prevent anything, just delays the operation.

The size of air valve is often made longer than the gas valve, as the amount of air required for combustion is about 1 gas to abt. 1.33 air of the same temperature and pressure. The gas has a temperature of about 1,000 deg. F. through the valve, and the temperature of the air is about 62 deg. F. Under constant pressure, the volume of air is directly proportionate to its absolute temperature, or

$$\frac{V_1}{V_2} = \frac{T_1}{T_2} = \frac{62 + 460}{1000 + 460} = \frac{522}{1460}$$

V_1 = vol. of gas at 62 deg. and V_2 vol. at 1,000 deg. Amount of air at 62 deg. required for combustion = $\frac{522}{1460} \times 1.33 = 0.48\ V_1$.

In other words, an air valve of an area equal to 0.48 of the gas valve area would be sufficient to supply the necessary air for complete combustion. Gas has an initial pressure at the producers of about 1½ in. w. g.,

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but most of this is lost before it reaches the reversing valves. We can safely figure that gas and air go through the valves under the same pressure, and the stack is generally the medium for drawing both gas and air into the furnace and dispose of the waste gases into the atmosphere. The gas checkers and flues get clogged up with soot and dust while the air flues stay nearly clean. On the other hand, the air regenerative chamber is usually larger than the gas chamber, because more heat has to be stored in the air checkers by the outflowing waste gases, requiring a greater proportion of these gases to go through the air chamber. This furnishes the only reason for large ports to the furnace and stack on the air valve. However, the combustion gases occupy 7 per cent smaller volume than the combined gas and air, when cooled off to the same temperature as these, and when we consider that the gas checkers will always stay much hotter than the air checkers at the valve end, almost twice as much combustion gases will flow through the air valve as compared with a gas valve of the same area.

To regulate the flow of gas and air a method should be used for constricting the areas at the reversing valves. For controlling the waste gases a furnace damper in each flue between checker chambers and valves should be used. In this way only can the process be under perfect control. In winter time the air opening must be less than in the summer. An excess of cold air into the furnace is nearly as much of a detriment to the operation as too little air. A surplus of air will have to be heated to furnace temperature, but a surplus of gas will mean a direct loss of gas to the atmosphere.

The valve system for a pit furnace requires special arrangements, as the gas and air is distributed and regulated for each pit on the furnace side of the reversing valves.

When soot and dust collect in the gas main, we get the cleanest gas at the top. An outlet at the bottom like Fig. 14 will serve as a dustcatcher. But in spite of this, we find it very common to see a gas outlet to a furnace underneath the main, and the flue run underground to the reversing valves. How easily the flue areas get clogged up with such an arrangement any furnace man can testify to. Some times it is necessary to burn out more than once a week. The gas ought to be taken off at the top, as in Fig. 15, and the shut-off valve for the furnace should be located right at the main. No watercooling is desirable on this valve, as this would require special attention in the winter.

A water seal of about 3 or 4 inches at the valve ports is always a guarantee against leaks. It can easily be arranged by having the valve project into the water of a pan, the shape of which will have to suit the particular valve. Water has so far been the only liquid used as a sealing medium. It has an advantage in that it can so easily be supplied and disposed of, but, as mentioned before, it also has some very serious drawbacks.

The gas as it leaves the producer carries along with it from 6 to 10 gallons of tar per ton of coal, gasified. A lot of this tar collects in the mains and can sometimes be seen dripping out of a leaky joint. If some of the tar were caught at the gas valve and used as a sealing liquid, there can be no reason why such an arrangement would not have some superior features over any existing gas valve. It is a known fact that a large amount of tar is precipitated at the valves, due to the watercooling. If we shape this valve to collect the tar, as in Fig. 20, we have a dependable seal, as it is raised up against the diaphragm, which shuts off to the gas main.

The writer has just applied for patent on a valve of this type, in which gas valve, air valve and reversing mechanism have been carefully designed to eliminate all the troubles with the present valves. The problems can be summarized briefly as follows:

The impact on seats when closing.

The abundance of open water for seal and cooling.

The complications of flue lay-out due to gas entering underneath the valve.

The dust collecting in flues adjacent to the valves.

To improve the mushroom valve to meet these conditions seemed easy, and it developed a system of reversing valves which now will be described. A general arrangement of valves is shown in Fig. 20 and a flue diagram is shown in Fig. 16. The gas enters from above and leaves most of the dust in the dustcatcher between the gas valves. In open position the valve seals over the port to the stack, with a deep trough around the valve proper. The trough is made of steel casting and is separate from the valve, and is held in position by keys. The tar is collected into this trough as it is knocked out of the gas by contact with the watercooled surfaces. In starting the operation, the trough must be filled with tar, and as it collects it overruns into the water pan at the bottom and is drained off with the water. In the lower position the tar is kept comparatively cool by the water, and in the top position, where it shuts off the gas, it is not subjected to heat from the sweeping gas. It is cooled to some extent also by radiation to the waterbox, which supports the top valve chamber. The cylindrical diaphragm which is used for a seal, is also a steel casting, and is hung on a seat of the water box. In starting up cold on a winter day the tar may be solid, and the diaphragm is then made to raise up with the valve until it becomes heated and sinks down on its seat. The valve and valve stem are watercooled, the water being supplied through a flexible hose.

The air valve has two bells, with corresponding water pans. There is no objection to the water here, as the air is taken in cold. The bell at the top has only half the stroke of the lower bell over the stack flue, and is so arranged that only half of its weight will act against the other bell. The valve area is regulated by a sector shaped plate resting on the ledge on the inside of the top water pan. One-third of the area is a solid rib, and the remaining 240 degs. can be reduced by the sector to whatever opening is required.

All the valves are operated together and have an absolute limited stroke, that will not permit the tar troughs and the bells of air valve to touch their waterpans. The motor directly drives a worm and wormwheel. On the wormwheel shaft is fastened a crank lever, which swings from one dead center to the other during a reversal, and the motion of the valves start from nothing, speeds up in the middle position and retards very gradually at the other end of the stroke. The crank lever connects through a link with a drum sector that has a groove for each rope from the four valves. The reversal is made in one or two seconds, and hardly any interruption is made to the operation of the furnace.

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Emporium Iron Company Rebuild Furnace

Arthur G. McKee & Company Have Completed Reconstruction Work on the Emporium Iron Company's Furnace, Emporium, Pa. —Mechanical Equipment Installed to Eliminate Human Labor.

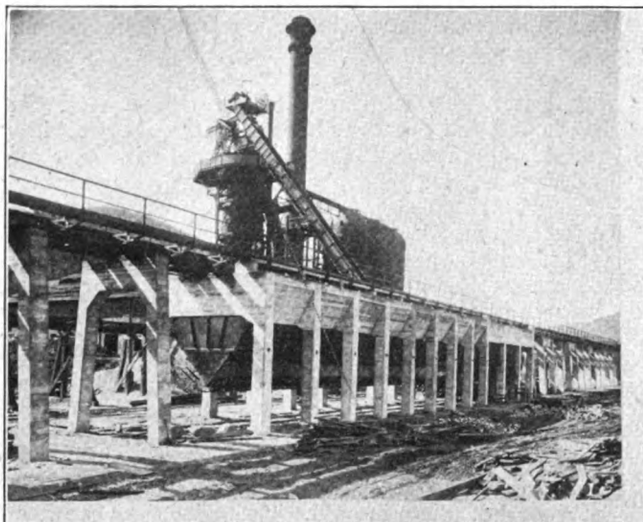
THE increasingly evident necessity of eliminating the human element in blast furnace operation and substituting mechanical equipment has again been demonstrated in recent plant reconstruction of the Emporium Iron Company, Emporium, Pa.

This plant, built during the years 1887-88, has operated since that time with substantially the original equipment. However, during the past year, the management decided upon radical changes and have replaced the old hand-filling system with a complete new set of storage bins, skip bridge, furnace top, etc. The furnace has been relined and partially remodeled, and new mechanical pig casting equipment installed.

Arthur G. McKee & Company, of Cleveland, were selected as engineers and contractors for the reconstruction work, their services including designing, furnishing of materials and the erection of same.

The alterations to the furnace below the mantle consisted of installing a new hearth jacket, 80 ft. deep by 16 ft. 4 in. inside diameter, made up of 1⅛-in. steel plate. Twenty-one cast iron hearth cooling plates were provided, approximately 8 ft. long by 2 ft. wide and 3 in thick. The old copper coolers were utilized, no new copper being furnished. Eight new tuyere stocks were installed, including elbows, blow pipes and base castings for attaching to the bustle pipe.

The storage bin and trestle structure is of steel and reinforced concrete, approximately 432 ft. long, and is



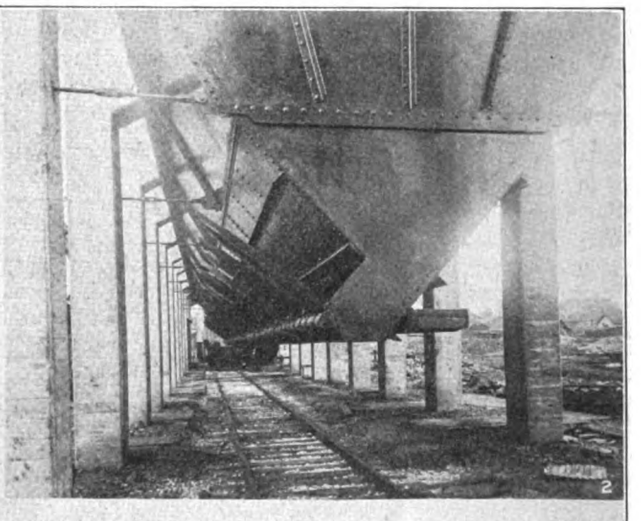


Fig. 1—Ship bridge arrangement.
Fig. 3—View of top of furnace.

Fig. 2—New bin arrangement.
Fig. 4—New mechanical pig-casting equipment.

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shown in the adjacent photographs. The coke bin, occupying three bays in the trestle structure, is 48 ft. in length and is made up of steel plate sides and bottom, suspended from the concrete bents. As indicated on Fig. 5, the coke bin is centrally located, discharging direct into the skip car, over McKee cascade type coke screens.

Eight ore and limestone bins of the Baker suspension type were installed, each bin being approximately 12 ft. in length and constructed of ⅜-in. steel plate sides and bottom. The bins are provided with a continuous line of segmental type gates arranged for convenient operation from the scale car platform, and discharge into an 80 cu. ft. capacity scale car, which delivers the material to the skip pit. The scale car is of heavy construction, is electrically driven and equipped with air brakes.

The charge is carried to the furnace top in a skip car of 80 cu. ft. capacity, traveling on a single track skip bridge, which is provided with deck plates to prevent materials falling through to the ground. The skip is supported by a hinged leg from the furnace top platform and rests on the old hoist tower as an additional means of support. At the upper end of the skip bridge is provided a sheave platform with a 5-ft. diameter cast iron sheave for accommodating the 1-in. plow steel skip hoist cable, idler sheaves being placed at different points along the bridge.

A 12x12-in. single drum Otis hoisting engine was installed in a brick hoist engine house, having concrete foundations and steel roof supports.

No changes were made to the existing furnace shell, a new top ring casting being furnished to fit the present design. There was also provided a new large bell hopper, made of cast steel in four sections, and a new gas seal of ½-in. steel plate with cast steel bottom ring and cast iron top ring. The gas seal contains two hinge type manholes, 30 in. in diameter, for removal or inspection of the small bell.

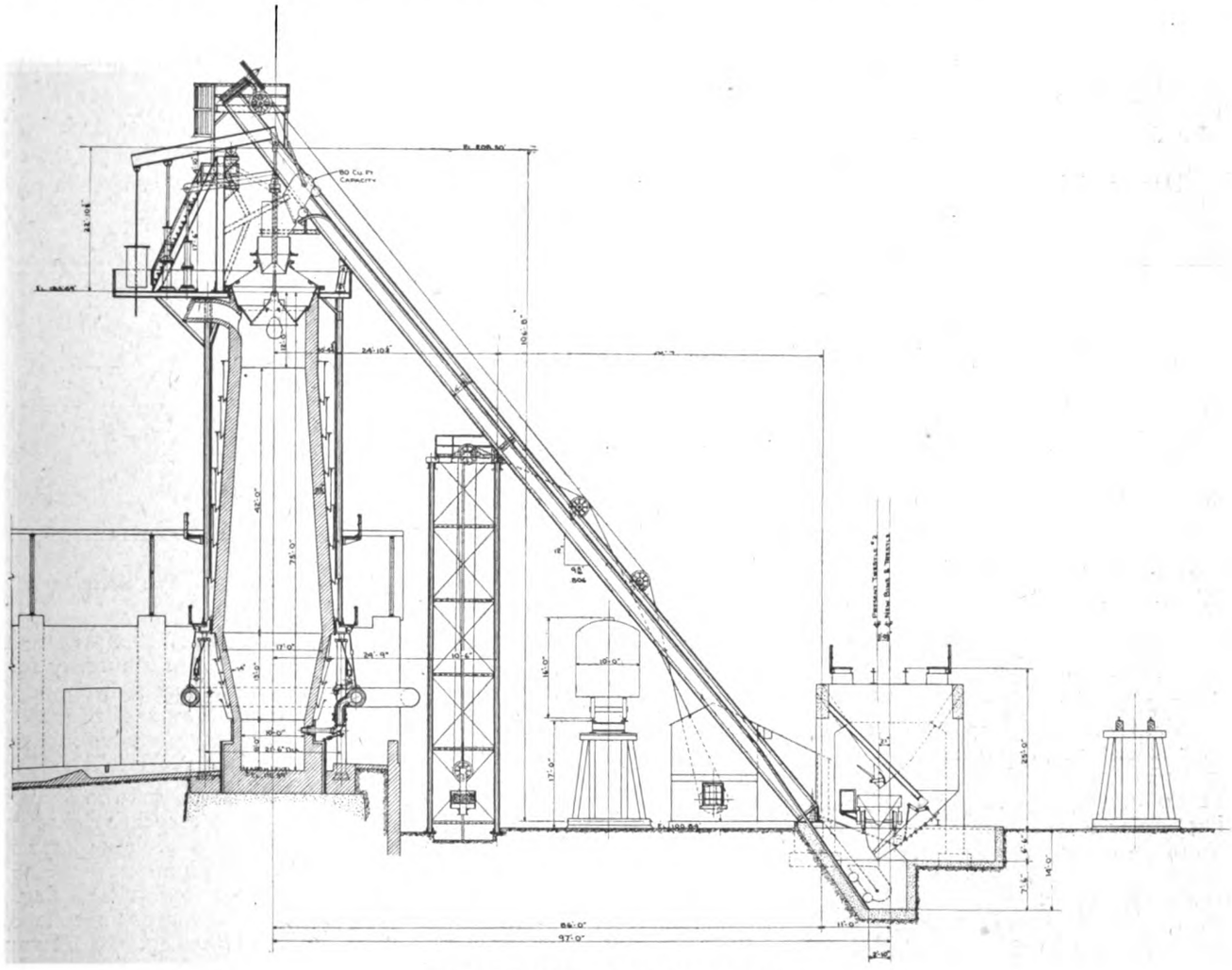

Fig. 5—Section through the furnace.

On top of the gas seal is mounted a McKee revolving stock distributor, consisting of small bell, bell hopper, small bell rod, ball races and drive mechanism. For operation of the revolving distributor a 7½-hp. Crocker-Wheeler, 220-volt, dc. motor was supplied, the motor being located on the furnace top platform and enclosed with proper housing. Control of the distributor is accomplished automatically by means of a limit switch connected to the hoist engine drum.

The furnace charge is discharged from the skip car into a receiving hopper constructed of ⅜-in. steel plate and provided with ½-in. wearing plates. Directly beneath this receiving hopper is a revolving hopper, which

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is of ¾-in. steel plate and which attaches to and revolves with the distributor.

An entirely new furnace top platform with 5/16-in. floor plates was furnished and erected. Supported on the top platform is a hand operated jib crane suitably designed for raising and lowering the large bell, hopper and other equipment. The operation of the large and small bells is accomplished by means of a bell rig mounted on the furnace top platform and consisting of 14-in. and 10-in steam cylinders, bell beams, counterweights, bearings and shafts. A modern test rod mechanism and indicator were also installed.

Stairs and walkways have been erected wherever necessary to give access for inspection or repairs, and guard railings and other safety features were installed in accordance with the State Code.

In the cast house, new iron and cinder runners were provided. The iron pours into a 50-ton Pugh type hot metal car and is then transported to the pig casting machine.

The single strand pig machine was furnished by the Pittsburgh Coal Washer Company, the supporting and housing structure for same being designed and erected by Arthur G. McKee & Company. The machine has a speed of approximately 20 feet per minute, carrying one pig mold per foot of chain, each mold casting a pig weighing from 100 to 125 lbs.

As the balance of the existing plant equipment was found adequate for operation with the improvements above described, no further changes were made, with the exception of the hot blast stove fittings. Each stove was equipped with complete new hot blast valve, chimney valve and air relief valve, all of McKee standard design.

Although existing conditions have made it inadvisable to operate the plant since completion of the reconstruction work, arrangements have been made to blow the furnace in at an early date.

The Structure of Coke

Modifications Described Which Occur in the Cell Structure of Coke from the Beginning of the Process to the Finish.

By H. D. GREENWOOD and J. W. COBB

VARIOUS views have been taken from time to time of the processes involved in the formation and structure of coke. These have been mainly concerned with the problem of the initial cell formation as distinct from any succeeding structural changes. A brief summary will not be out of place.

Coke is generally regarded as formed by the liquefying of easily fusible constituents of the coal followed by decomposition, the formation of cells by the inflating effect of escaping gas, and gradual solidification. Wedding attributed the formation of coke to the decomposition of the richer gaseous hydrocarbons. According to Lewes ("Carbonization of Coal") the heat passing gradually from layer to layer of the charge drives before it the heavy tars; these are alternately deposited and redistilled with some decomposition, which becomes responsible for the formation of coke.

S. R. Illingworth develops the view that the formation of coke and its resulting structure are dependent upon the volume and rate of evolution of gas given off during the period in which the material is in a plastic condition.

It is known that coking coals undergo a partial liquefication at about 450 deg. C. The plasticity may safely be attributed to the melting of certain constituents of coal and their impregnation of the mass. The gases evolved by the decomposition of these and other constituents are responsible for the formation of pores or cells in a mass which gradually stiffens to rigidity as the decomposition proceeds. Further evolution of gas occurs as the temperature rises, which modifies the cell structure without altering its fundamental character, although the modifications have their own technical importance.

In the following paper we have attempted to trace these later changes in the coke from the newly formed cell structure to the final formation of high-temperature coke.

To this end cokes were prepared from the same coal in the laboratory at three different temperatures, 550 deg. C., 850 deg. C. and 1100 deg. C., and the cokes were examined. These may be taken respectively to represent approximately the products of low-temperature carbonization (550 deg. C.), medium-temperature carbonization as in horizontal gas retorts (850 deg. C.), and high-temperature carbonization as in coke ovens making metallurgical coke (1100 deg. C.) A parallel examination was made of a commercial sample of hard by-product coke for comparison with the 1100 deg, C. experimental coke.

Preparation of Coke

The same coal was used in the preparation of these cokes, these having the following composition: Carbon 77.36 per cent, hydrogen 5.66 per cent, sulphur 1.65 per cent, nitrogen 1.34 per cent, oxygen 10.22 per cent, ash 3.77 per cent. Volatile matter 37.3 per cent (American crucible method, 1899). It was the Nottinghamshire (New Hucknall) gas-coal used by Hollings and Cobb in their study of thermal phenomena in carbonization (Trans. Inst, Gas Eng., 1914, 225-277). The coal was coked in pieces of pea size in a large fireclay crucible holding about 400 grams, and fitted with a lid, through which a hole was bored for the insertion of a thermocouple. The couple was protected by a silica sheath, and the junction maintained about one

*Abstract of paper read before the Society of the Chemical Industry.

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inch from the bottom of the crucible. Before coking the lid was cemented to the crucible.

Each coal was raised to the desired temperature in about three hours and maintained at that temperature for another three hours—six hours altogether. Cooling in situ followed.

After cooling, the coke was extracted and ground to pass between one-third-inch and one-quarter-inch mesh sieves, thus giving fragments of an average diameter of 3 mm., the coke within one-half inch of the crucible wall being discarded.

The by-product coke was obtained from the quenching bench of an Otto by-product battery (Robin Hood Colliery, Yorkshire).

The changes in weight, specific gravity, volume and porosity undergone in the carbonization process were then determined.

Determination of Specific Gravity and Porosity of the Coke

The terms "real" and "apparent" are generally used with reference to the specific gravity of the material composing the walls of the coke cells, and of this material together with the cells, respectively. We shall deal with three different specific gravities for any one sample of coke. In place of "real specific gravity," the term "specific gravity of coke material" will be used; in place of "apparent specific gravity" the term "specific gravity of material and all cells," the third specific gravity being that of the "material and closed cells."

Determination of the Specific Gravity of the Coke Material

The coke was ground to pass a sieve of 60 meshes to the inch, and about 1 g. of this powder was exhausted under water in a specific gravity bottle heated on a water bath. The exhaustion was continued for about three hours, then the bottle was disconnected and the specific gravity determined in the usual manner. On filling the bottle in the ordinary way after exhaustion, flakes of coke floating on the surface are lost, thus introducing an appreciable error. To avoid this, the exhaustion was carried out with the stopper in situ, and when complete the bottle was completely exhausted and the rubber connecting tube opened under water; in this way the bottle could be filled without loss of material. A catch bulb was usually placed above the bottle to prevent any loss by spirting.

The same method was used to determine the specific gravity of the "material + closed cells," with the exception that fragments of coke were used in place of the powdered material.

The values so obtained were somewhat lower than with the powdered coke, owing to the presence of "closed cells," into which the water could not penetrate.

Specific Gravity of Material + All Cells

This determination was carried out in a volumenometer (Anderson, J., 1896, 20) which consists essentially of a wide glass tube fitted with a ground glass stopper terminating in a glass stopcock, the other end being connected by rubber tubing with a burette. The tube is filled with water and a known weight of coke introduced, the coke being in fragments of the largest size which can enter the tube.

From the volume of water displaced, measured on the burette, the specific gravity of the coke fragments can be determined. The accuracy of the determination is dependent primarily upon the nonpenetration of the water into the coke cells, and upon any small volume of gas expelled from pores by the water being the same before and after expulsion. With the 850 deg. C. coke, considerable volumes of gas were evolved on immersion in water, but by taking readings quickly, or, better, by replacing the water by mercury, consistent results were obtained.

From the specific gravities thus determined, it is possible to calculate the porosity of the coke.

Let specific gravity of the coke material = A.

Let specific gravity of the coke material + all cells = B.

Let specific gravity of the coke material + closed cells = C.

Then % total porosity (by volume) = 100(1—B/A (1)

Then % closed pores (by volume) $\frac{100B\ (A—C)}{A.C.} = (2)$

By subtracting (2) from (1) we are left with the percentage of "open pores." The results thus obtained are collected in Table I.

Table I—Changes in Porosity and Specific Gravity in Coking

Temp. of coking. Deg. C.	Sp. gr. of coke material	Sp. gr. of material and all pores	Sp. gr. of material + closed pores	Per cent open pores	Per cent closed pores	Per cent total porosity
Original coal	1.270	1.270	.....	.....	.....	.....
550° C.	1.591	0.879	1.446	39.2	5.5	44.7
850° C.	1.870	0.888	1.563	43.17	9.33	52.5
1100° C.	1.870	1.014	1.631	37.85	7.95	45.8
By-Product (hard)	1.880	1.012	1.720	40.6	5.0	45.6

The results obtained by Anderson, given in the paper already quoted, are similar to those shown in Table I, and it is of interest to note the difference which he obtained when using fragments of coke as compared with powdered coke for exhaustion in the specific gravity bottle.

Specific gravty of—	1.	2.	3.
(a) fragments of coke	1.623	1.666	1.730
(b) Powdered coke	1.832	1.850	1.880

These differences, although not strictly comparable with ours, are of the same order of magnitude.

It will be seen from Table I that the "coke material" had attained a density at 850 deg. C. or by-product "coke material."

From these results we have calculated the changes in volume and specific gravity which the coal underwent on coking, and which have a bearing on the structure of the resulting coke. Thus the figures in Table II indicate the changes in volume, etc., undergone by 100 g. of coal on heating to 1100 deg. C. in three stages.

When a coking coal is heated to about 400 deg. C. it undergoes a partial liquefication, due doubtless to the presence of substances melting at about that temperature. Further heating causes the decomposition of these and other substances, the mass becoming decreasingly plastic. Bubbles of gas force their way through the semi-plastic material and form cells or pores which permanently retain their shape when the mass has attained a certain degree of rigidity. In the further decomposition, the plasticity is so small that the evolution

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of gas causes no such change in the material, which remains as a porous mass—coke.

The formation of the cells is accompanied by a swelling of the mass. It is probable that between 450 deg. and 500 deg. C. the swelling of the coal is considerably greater than would appear from Table II, the semi-plastic stage having been passed and the general contraction begun below 550 deg. C.

The porous material formed consists of sealed and unsealed pores with walls of semi-carbonized material.

Table II—Changes in Weight and Volume in Coking

	Wt. g.....	Vol. of coke (or coal) + all pores, c.c.....	Vol. of coke (or coal) material c.c.....	Total vol. of pores, c.c.....	Change in vol. at each stage as per cent of original coal volume.	
Original coal....	100	78.8	78.8	....)	Inc	2.8
Coked at 550– C.	71	81.0	44.6	36.4)		
Coked at 850° C.	64	72.0	34.2	39.8	dec.....	11.4
Coked at 1100° C	63	63.0	33.7	29.3	dec.....	11.4
Total change from 15° to 1100° C.	–37	–15.8	–45.1	+29.3	nett dec.	20.0

The specific gravity of the cell walls is greater than that of the original coal, but the specific gravity of the mass as a whole is less than that of the coal.

There is some gain in total volume in spite of the great loss of weight. The cell structure is developed at 550 deg C., but further heating causes considerable changes in the coke material, with accompanying changes in the porosity of the mass.

Heating at 850 deg. C. results in a further evolution of gas, entailing a decrease in the mass and volume of the coke material. The mass as a whole shrinks to the extent of 11.4 per cent of the volume of the original coal, but owing to the loss in weight and increased density of the coke material, the porosity increases by 7 per cent, giving the maximum value observed, 52.5 per cent. The effect of this change is to give a coke with larger cells, the walls of which are, however, composed of denser and harder material.

The effect of the increase in density of the material (from 1.59 to 1.87) appears to overbalance the reduction in strength arising from the enlargement of the cells, since this coke is substantially stronger than the 550 deg. C. coke.

Between 850 deg and 1100 deg. C. a further shrinkage of 11.4 per cent takes place in the mass as a whole, but the process is otherwise not the same as in the previous stage. The loss if weight is only 1 per cent, the specific gravity of the coke material is unchanged, but the porosity falls again to 45.8 per cent.

A considerable thickening of the cell walls must have taken place, and is probably the principal cause of the accession of strength in this stage, although the deposition of bright carbon on the cell-walls resulting from the decomposition of methane in contact with them, is also likely to play its part. The coke at 1100 deg. C. is, therefore, made up of smaller cells than at 850 deg. C. with thicker walls; it is a stronger material.

The values for the various specific gravities and porosities of the by-product coke are very similar to those obtained for the 1100 deg. C. laboratory coke.

Summarizing, we can divide the formation of high-temperature coke into three stages:

1. The first stage up to 550 deg. C. is constituted by the initial cell formation, these cells having relatively thick walls of soft material of low specific gravity, the process being accompanied by a swelling of the charge.

2. Between 550 deg. and 850 deg. C. the mass as a whole shrinks and an increase in specific gravity of the coke material ensues, the resulting coke having thinner but stronger walls and the porosity reaching a maximum.

3. In the last stage the predominant factor is a further large contraction of the mass as a whole, the coke material undergoing no appreciable increase in specific gravity. We are thus left with a strong coke, constituted of small pores with relatively thick walls. At no stage in coking to 1100 deg. C. does the material approximate to the specific gravity of graphite, 2.3.

We have followed the process in a fairly typical gas coal, but believe that its essential features would be reproduced in the behavior of coking coals generally.

It may be mentioned that the swelling of the coal in the first stages of carbonization is well known to cause difficulties in withdrawing coke made at low temperatures, and in promoting sticking at the top of the charge in continuous vertical retorts and gas producers, particularly when fitted with a bell.

ISSUES BULLETIN ON STUDY OF ALLOY STEELS

Studies in the experimental production of certain alloy steels are discussed by H. W. Gillet, chief alloy chemist and E. L. Mack, assistant alloy chemist, in a bulletin which has just been published by the United States bureau of mines.

The production of small heats of alloy steels on an experimental scale often is desirable in beginning the study of new alloy steels before large amounts of expensive alloys are used in heats of commercial size. Such small heats sometimes can be made up at crucible steel plants, but few crucible steel makers care to undertake experimental heats for other firms. Small electric furnaces offer some advantages over crucible furnaces for experimental work, and various types ofsuch furnaces are being successfully used by different firms for such work. The bureau of mines recently made up experimental heats of alloy steel for the army and the navy. The steels for the army were desired for work on gun erosion, especially as regards the effect of nitrogen on steel. The request from the war department for this experimental work was made during the course of the world war and followed the receipt of information from a creditable source that Germany was using uranium steel in the liners of some high-power naval guns. It was stated that uranium stiffens steel at high temperatures, and raises the softening point some 200 deg. C. so that gun erosion is reduced. The fact that the German guns retained accuracy of fire at the end of the Jutland naval engagement was ascribed to the uranium-steel gun liners.

BORON AS A STEEL ALLOY

Experimental work performed by the United States Bureau of Mines indicates that the use of boron as an alloy confers marked hardness on steel. If the other physical properties of the boron steels are good enough to be applicable to commercial use, their remarkable plasticity at temperatures below the melting points of ordinary steels might make it possible to utilize this characteristic.

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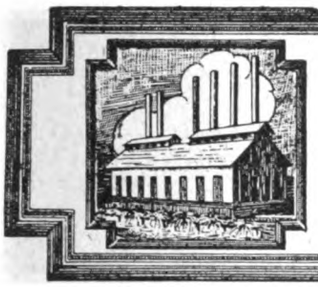
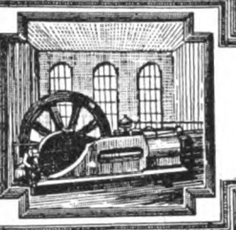


STEAM POWER DEPARTMENT

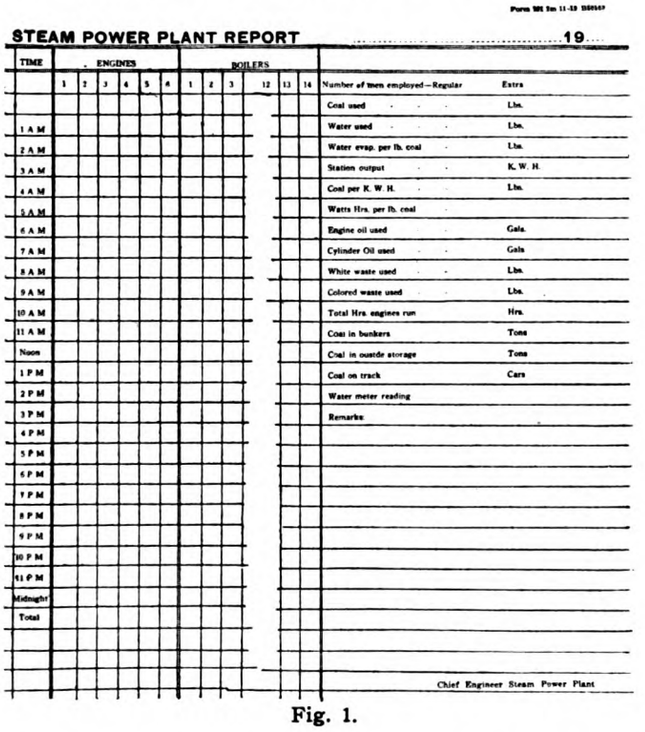


Steel Works Power Plant Management

A Continuation of the Series on Power Plant Accounting and Recording, Giving Performance Logs—Manner of Keeping Performance Records Has Changed During Last Few Years.

By ROBERT JUNE, Associate Member A. S. M. E.

THE keeping of performance records in the power plant is a rule rather than the exception even in small plants. In this respect there has been considerable change in practice during the past five or six years. When both coal and labor were cheap there was less incentive to keeping records. Today it is not a question of whether records shall be kept, but rather of what form these records shall take in order that they may be of the greatest practical value.



STEAM POWER PLANT REPORT ..... 19...

TIME	ENGINES 1	2	3	4	5	6	BOILERS 1	2	3	12	13	14
1 A M												
2 A M												
3 A M												
4 A M												
5 A M												
6 A M												
7 A M												
8 A M												
9 A M												
10 A M												
11 A M												
Noon												
1 P M												
2 P M												
3 P M												
4 P M												
5 P M												
6 P M												
7 P M												
8 P M												
9 P M												
10 P M												
11 P M												
Midnight												
Total												

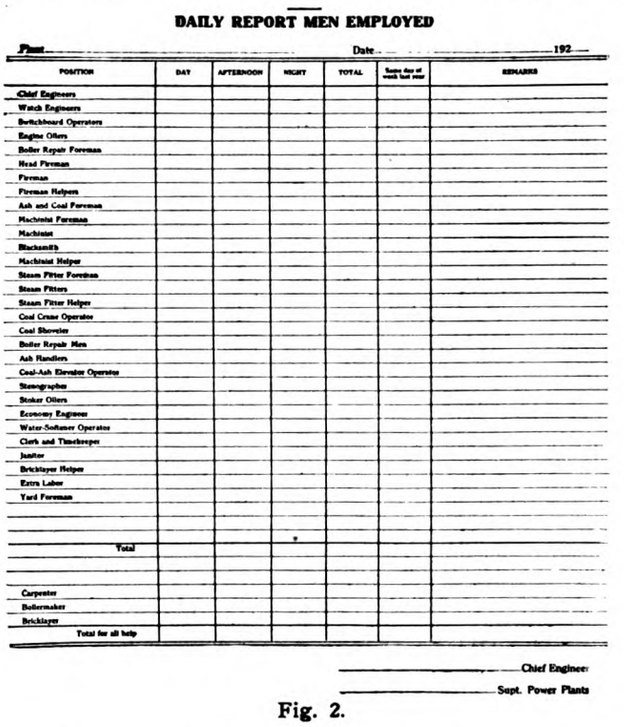
Number of men employed—Regular	Extra
Coal used	Lbs.
Water used	Lbs.
Water evap. per lb. coal	Lbs.
Station output	K. W. H.
Coal per K. W. H.	Lbs.
Watts Hrs. per lb. coal	
Engine oil used	Gals.
Cylinder Oil used	Gals
White waste used	Lbs.
Colored waste used	Lbs.
Total Hrs. engines run	Hrs.
Coal in bunkers	Tons
Coal in outside storage	Tons
Coal on track	Cars
Water meter reading	
Remarks	

Chief Engineer Steam Power Plant

Fig. 1.

It should be recognized, first of all, that the compilation of unnecessary data is to be avoided. By unnecessary data, we mean information relating to conditions which cannot be changed. The second consideration is that all records compiled should at all times be available to the men who control the figures which go to make up the records. That is to say, the boiler room superintendent should, at all times, know the amount of coal which he is using and he should have before him the records of previous performances for the sake of comparison.

As a matter of fact, records should be kept by the men who are actually doing the work, and not by outside clerical help.



DAILY REPORT MEN EMPLOYED

Plant ..... Date ..... 192...

POSITION	DAY	AFTERNOON	NIGHT	TOTAL	Same day of week last year	REMARKS
Chief Engineers						
Watch Engineers						
Switchboard Operators						
Engine Oilers						
Boiler Repair Foreman						
Head Fireman						
Fireman						
Fireman Helpers						
Ash and Coal Foreman						
Machinist Foreman						
Machinist						
Blacksmith						
Machinist Helper						
Steam Fitter Foreman						
Steam Fitters						
Steam Fitter Helper						
Coal Crane Operator						
Coal Shoveler						
Boiler Repair Men						
Ash Handlers						
Coal-Ash Elevator Operator						
Stenographer						
Stoker Oilers						
Economy Engineer						
Water-Softener Operator						
Clerk and Timekeeper						
Janitor						
Bricklayer Helper						
Extra Labor						
Yard Foreman						
Total						
Carpenter						
Boilermaker						
Bricklayer						
Total for all help						

Chief Engineer

Supt. Power Plants

Fig. 2.

The next point is that the operating men should not be bothered with dollars and cents computations. They cannot control the price of coal, or oil, or waste, or other materials, and they cannot control the price of labor. They have nothing to do with overhead or

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OFFICE OF
Superintendent of Power Plants

DAILY OPERATING REPORT _____ 192__

DATA	ANDERSON		EATON	
	THIS YEAR	LAST YEAR	THIS YEAR	LAST YEAR
Total K. W. H. Generated				
Station Service K. W. H.				
Net K. W. H. Output				
Peak K. W. Load				
Max. hr. K. W. H.				
Ave. hr. K. W. H.				
Ave. Demand Factor				
Totals lbs. Coal Used				
Lbs. Coal per K. W. H.				
Total lbs. Water Used				
Lbs. Water per K. W. H.				
B. H. P. H. Connected				
B. H. P. H. in Service				
B. H. P. H. Banked				
Percentage of Boiler Banked				
Max. of H. P. of Boilers in Service				
Total lbs. Steam to Shop				
Coal in Bunker, Tons				
Coal in Storage, Tons				
Total Coal, Tons				
No. of Men Employed				

Report power failure and cause, also larger items of repairs or inspection.

Compiled by_____ Approved_____Supt. of Power Plants

Fig. 3.

fixed charges, therefore do not confuse them by asking them to deal with monetary values, but let your records be kept and let them stand or fall upon their economical use of coal in tons, oil in gallons, waste in pounds, and labor in hours. Records kept by the men place at their disposal information which enables them to determine the performance, ability and economy of the equipment under their charge, so they can

Fig. 4—Daily operating log.

	12-8 A.M.	8-4 P.M.	4-12 P.M.
Feed water meter reading			
Lbs. water by F. W. meter			
No. of boiler blow downs			
Average inches per blow			
Lbs. water blow down			
Nos. of boilers filled			
Lbs. of water used for filling			
Lbs. water evaporated			
Average steam pressure			
Average F. W. temperature			
Factor of evaporation			
Average hp. developed			
Average hp. per boiler			
Average % rating			
Total lbs. coal fired			
Lbs. ash and refuse			
% ash and refuse			
No. combustion chambers cleaned			
% of moisture in coal			
Total lbs. dry coal fired			
Average CO_2			
Average CO			
Boiler efficiency % (total 24 hours only)			
Above standard % (total 24 hours only)			
Below standard % (total 24 hours only)			
Average Evap. actual			
Aver. Evap. Fr. and at 212 per lb. dry coal			
No. of fan operated			
.....Foreman			

strive to better the output while decreasing the consumption of materials and labor.

Reports to the management in which dollars and cents computations are involved should, in all cases, come through the accounting department where the costs of the various items can be readily and expertly set up. The amount of detail in the reports for the management and the frequency with which such reports are submitted depends upon the use to which they are to be put. Nothing unnecessary should be included. If the total output of the power plant and the total cost of fuel and wages are all that are desired, the report should be limited to these items.

If, however, reports are to go to an executive who exercises a direct hand in the supervision of the power plant, the reports should include such information as

Fig. 5—Power house time card.

Location..... Date....., 19..

Nature of Work	Acct. No.	Hours	Rate	Amt.
Switching cars for roadway				
Cleaning yard				
Repairs to boilers, P. H. machinery, stokers, conveyors, etc.				
Engineer				
Oiler				
Water tender				
Fireman				
Boiler washing				
Unloading coal				
Miscellaneous P. H. labor				
Wheeling coal and ashes				
Cleaning fires				
Loading and delivering coal to sub-stations				
Loading and delivering coal to station				
Work for Motive Power Dept.				
TOTALS				
Correct Signed				

Chief Engineer.....

quality and quantity of coal, with special reference to the ash and moisture in the coal, the amount of oil, water and various boiler and engine room supplies used, and the separation of labor costs in the boiler and engine room help.

As the size of the plants increase it is desirable to include detail records of the number of hours of service rendered by each unit over daily, monthly and yearly periods, hourly flue gas temperature, barometric steam pressure and feed water temperature readings. By comparing such records a close check may be kept on plant efficiency and it is possible to determine the real value of expenditures for equipment so that future purchases may be made to best advantage.

It has been found practical dollars and cents value to keep constant records of such items as air pressure below grate, furnace draft, CO_2 in flue gas, as well as to watch smoke, to record tests of boilers, pumps and engines, keep close track of repairs and note the capacity of stokers, coal and ash-handling equipment, etc.

The personal equation and the problem of the individual plant will lead to placing emphasis on certain details of operation in one plant and placing this emphasis on other items in another plant. Log sheets should properly be individualized to meet the particu-

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lar conditions in the plant where they are used, and it will be of interest to examine typical records which can be modified for individual use.

Fig. 1 shows the daily log sheet turned in by the chief engineer of each steam power plant operated by one well known company. It will be noted that this log deals only with quantities of material and hours of operation.

Fig. 2 is the report of men employed, used by the same company. This report is turned by the chief engineer to the office of the superintendent of power plants. In the latter office, computation of the cost of labor are made an dare added to the report so that the superintendent, at least, has the labor cost before him.

Fig. 3 is the combined operating report for all the

Fig. 6—Report of water softening and purifying system.

No..... Date.....

H—Hardness or Soap Test.....
C—Indicates Causticity or Phenolphthalein Test.....
A—Indicates Alkalinity or Methyl Orange Test.....

Chemicals in Stock { Lime..... Soda.....

Day	Date	Gallons Water Treated	Hours of Operation	Gallons Chemical Solution		Lbs. per 1,000 gal. Solution		Time of Charges	Temperature Treated Water	Raw Water		Treated Water		
				Lime	Soda	Lime	Soda			H	A	H	C	A
Sunday														
Monday														
Tuesday														
Wednesday														
Thursday														
Friday														
Saturday														

Remarks: .....

.....

.....

.....

.....*Chief Engineer.*

Form 11358-500-4-20 SHEET No. 1

BOILER HOUSE OPERATION COSTS

PLANT FROM..... TO .....

	Man Hrs	Av. Rate Per Hr	Total Cost	Cost Per Bbl Oil Fired	Cost Per 1000 lbs Water Evaporated	Cost Per Boiler h. p. hr
(1) Fuel Petroleum F. O. B. Plant						
(2) Unloading Oil and delivering to storage tanks, including pumping into working tanks						
(3) Steam for pumping to storage and working tanks, and heating systems						
(4) Delivering oil from working tanks to burners						
Total delivering oil from tanks to burners						
(5) Firing boilers (including cleaning of burners						
(6) Boiler Cleaning						
(7) Boiler room supplies (oil, waste, compound)						
(8) Repairs Labor—						
(a) Buildings						
(b) Oil Lines—supply pumps and heating systems						
(c) Boilers, breechings and stacks						
(d) Oil burners and oil feed pumps						
(e) Boiler room piping						
(f) Tools						
Total Repairs—Labor						
(9) Repairs—Material—						
(a) Buildings						
(b) Oil Lines—Supply pumps and heating systems						
(c) Boilers, breechings, stacks						
(d) Oil burners oil feed pumps						
(e) Boiler room piping						
(f) Tools						
Total Repairs—Materials						
Total Repairs—Labor and Material						
(10) Direct boiler room superintendence						
(11) Proportion of cost of Power Supt and Staff						
Total S. per. tendence						

Form 11358B 500-4-20 SHEET No. 2

BOILER HOUSE OPERATION COSTS---Continued

PLANT FROM ..... TO .....

	Man Hrs	Av. Rate Per Hr	Total Cost	Cost Per Bbl Oil Fired	Cost Per 1000 lbs Water Evaporated	Cost Per Boiler h. p. hr
(12) Steam for oil feed pumps						
(13) Steam for burners						
(14) Steam for forced draft						
(15) Compressed air for cleaning tubes						
(16) B. R. Steam for blowing tubes						
(17) Electricity for lighting at per kw. hr						
Total Boiler Room Auxiliaries						
(18) Water at per M gal delivered to reservoir						
(19) Electricity for pumping feed water to heater at per kw. hour						
(20) Steam for B. F. Pumps.						
(21) Steam for boiler cleaning air compressors						
(22) Labor in operation boiler feed pumps and boiler cleaning air compressors						
(23) Supplies B. F. Pumps and B. C. air compressors						
(24) Repairs, Labor B. F. Pumps and B. C. air compressors						
(25) Repairs, Material B. F. Pumps and B. C. air compressors						
Total water for boiler feed and boiler cleaning delivered to boilers						
Grand Total Costs of Boiler Room						

Total Fuel Oil Fired (Bbls.) .....
Total Water fed to Boilers .....
Total Water Blown Down (including leakage) .....
Total Lbs. Water Evaporated .....
Total B. H. P. Hours Delivered .....
Average F. W. Temperature .....
Average Steam Pressure .....
Equivalent evaporation from and at 212°—lbs. Water per lb. Dry Fuel Oil .....
Actual % Rating Developed .....
Average B. T. U. per lb. Dry Fuel Oil (calculated) .....
Average % Moisture in Fuel Oil .....
Average B. T. U. per lb. Fuel Oil Fired .....
Average Boiler Efficiency .....

Fig. 7.

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power plants and is made up from the logs shown in Figs. 1 and 2, for all plants. The logs just referred to deal with the units of time and material, and the unit of output. A more intimate record of operating conditions, however, is desirable. This is to be obtained by making a record of such data as the following:

In conjunction with the use of the log in Fig. 4, the chief engineer will also want detail record of the time put in by different men on different jobs. This record can be in the form shown in Fig. 5.

In this case the chief engineer will make this form out in triplicate, filling in only the hour's col-

MELAPP No. 11 **TIME RECORD** No.

Name _____ Occupation _____

MUNICIPAL ELECTRIC LIGHT AND POWER CO. RATE _____

Date	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 / 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	Acct.	Hours	Dollars	Cts.
Engine Room Operation		P 2			
Boiler Room Operation		P 30			
Maintenance of Engine No. 1		P 10-1			
Maintenance of Turbine No. 2		P 10-2			
Maintenance of Turbine No. 3		P 10-3			
Maintenance of Engine No. 4		P 10-4			
Maintenance of Turbine No. 5		P 10-5			
Maintenance of Generators		P 12			
Maintenance of Boiler No. 1		P 35-1			
Maintenance of Boiler No. 2		P 35-2			
Maintenance of Boiler No. 3		P 35-3			
Maintenance of Boiler No. 4		P 35-4			
Maintenance of Boiler No. 5		P 35-5			
Maintenance of Boiler No. 6		P 35-6			
Maintenance of Boiler No. 7		P 35-7			
Maintenance of Boiler No. 8		P 35-8			
Maintenance Boiler, Aux. Equip.		P 35-9			
Maint. of P. P. Aux. Equip		P 11			
Maint. of Aux. P. P. Elec. Equip		P 13			
Maint. of Coal and Ash H. Equip.		P 36			
Coal Wheelers		P 31			
Electric Labor		P 3			
Miscellaneous Labor		P 4			
Maintenance of P. P. B. F. and G.		P 14			
Maintenance of B. P. B. F. and G.		P 37			
Maintenance of S. D. B. F. and G.		U 6			
Maintenance of S. D. Equip.		U 6			
Operation of Store Room		U 4			
Steam Power Plant B. F. and G.		TC 10			
Boiler Plant B. F. and G.		TC 13			
Steam Power Plant Equipment		TC 30			
Boiler Plant Equipment		TC 34			
Miscellaneous Equipment		TC 50			

Foreman _____

Chief Engineer _____

Manager _____

Fig. 8.

umn. The office of the superintendent of power stations will fill in rates and amounts, and send a copy of each to the accounting department, who will set up the charges. By constant reference to these time cards, the chief engineer will have a ready comparison between the performance on any given date and the average time required for similar work.

Fig. 6 is a report on the water softening and purifying systems. Reports of this character should not only be used for water softening apparatus, but for any other special equipment.

Fig. 7 is a form for weekly, monthly and yearly reports of boiler house operating costs. This chart was developed by one of the keenest engineering organizations in the country and is in constant use for recording costs in a large number of power plants under its supervision.

Fig. 8 is the semi-monthly time record employed by another operating company with a municipal power plant. This record shows the maintenance cost of all important units of equipment.

Fig. 9 is a daily graphic chart kept in the power superintendent's office of the operating company referred to above. This chart is plotted daily on cross section of cloth. At the end of every month, the monthly average curve is drawn on the chart in red. This graphic record is always available, and when desired the charts for a year or more back may be

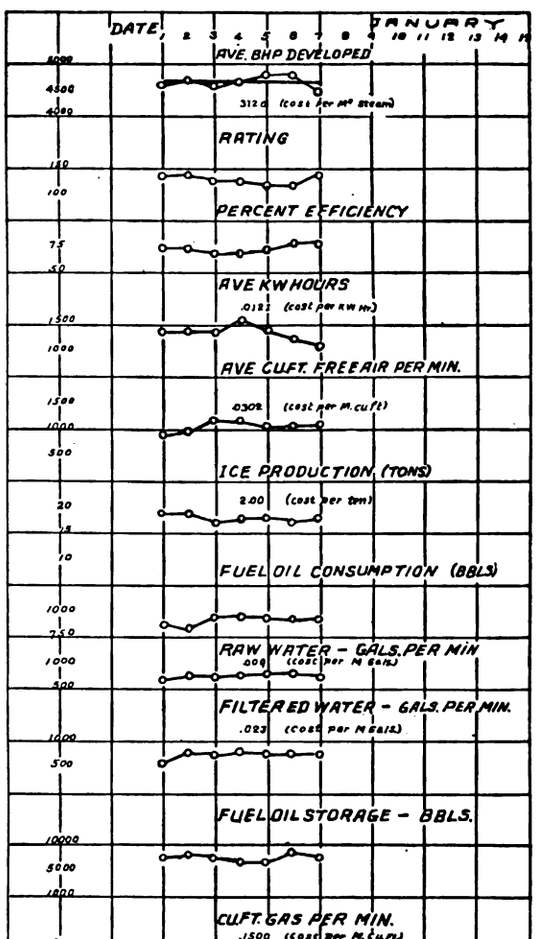

Fig. 9.

tacked up on the bulletin board as an object lesson to all operating men.

As stated above, the performance log should be drawn up to meet the individual conditions obtaining in each plant. There is one danger in doing this, however, in that there is frequently a temptation to include too much irrelevant data. The things with which everyone should be concerned are those factors in operation which have an important bearing upon the total cost of production and which can, in some measure, be controlled.

It is perfectly useless for operating men to make records covering factors which cannot be controlled. Let the operating men center their efforts on such principle points as coal consumption per kw. hour and men per hour required for various operations, and improvements in operating conditions will result.

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Oil and Coal Mixed Used for Fuel

The United States Bureau of Mines Suggests a Mixture of Oil and Coal, Which Bears a Relationship to the Trent Process, as an Emergency Fuel.

As an emergency fuel, a mixture of fuel oil with fine coal in as large proportions as the coal will absorb and hold is suggested by the United States Bureau of Mines to steam coal users and gas manufacturers to augment their fuel supply during the present shortage.

Slack coal that has a high percentage through an 8-mesh screen, or which may be crushed to sizes of ⅛ inch or less, will take up in oil from 30 to 40 per cent of its own weight and make a fuel high in calorific value. Coarse slack coal, however, as judged by a representative sample from the Pittsburgh market, will absorb oil to only 3 to 10 per cent of its own weight, which would give a fuel having only about 4 to 15 per cent increased heating value. The finer the size of the coal, therefore, the larger is the amount of oil which will be held. Tests made by the Bureau of Mines at its Pittsburgh experiment station indicate that the mixture can be made with either bituminous slack or anthracite culm.

This method bears a relationship to the Trent process of purifying coal by fine grinding and amalgamation with oil, now in operation at a plant at Alexandria, Va., which has demonstrated the success of a combination of oil and coal for steam-making, gas manufacturing and other fuel purposes. The present emergency proposal does not contemplate the cleaning process, but involves merely the simple mixing by shovel or concrete mixer. The Trent Corporation has volunteered to assist the Government in advising in the use or application of oil-coal mixtures, and to waive, during this emergency, any claim of infringement of its process which may or may not be involved by the simple mixing of fuel oil and coal, without reference to cleaning.

An oil refinery at Baltimore, it is reported, mixed by shovel a ton of heavy Mexican fuel oil with two or three tons of Western Maryland slack coal, and used it successfully in a switch engine. At the experiment station of the Bureau of Mines at Pittsburgh it was found that mixtures containing one ton of Mexican fuel oil and four to five tons of Pittsburgh slack coal could be used in a hand-fired furnace.

In using oil-coal mixtures, the fire will smoke badly after firing, or while breaking up the coke bed from time to time. From such limited amount of testing as has been done by the Bureau of Mines, it was shown that careful firing is required to prevent continuous smoking. Experimenting must be done in each case to determine the best method of firing.

Chain grates and certain other automatic stokers are probably well adapted to handle the oil-fuel mixture if the bin and feeding devices are suitable. Oil-fuel mixtures will not fire spontaneously, but undoubtedly care should be exercised to ventilate bins where external heat may tend to drive off lighter gases, although the fuel oil which is on the market has had the lighter oils distilled from it.

Anthracite culm dust which would sift through ordinary grate bars can be used successfully when mixed with the oil, as the oil causes it to adhere and the oil residue cokes as soon as heated. Oil and anthracite mixtures are not smokeless with hand firing, the Bureau of Mines tests indicate.

This simple mixture of fuel oil and coal is proposed by the Bureau of Mines merely as a temporary measure. While under conditions of normal fuel supply such a mixture probably would not prove satisfactory unless it involved the cleaning feature embraced in the Trent process. In places where fuel oil is available it can be used to piece out a poor coal supply without the changes in equipment necessary to convert boilers to oil burning.

NEW OVENS TO BE BUILT BY KOPPERS

The Koppers Company has been awarded a contract to build 366 by-product coke ovens of its new design for the Carnegie Steel Company at Clairton, Pa., together with a by-product plant and benzol plant. These ovens will be of the combination type, so arranged that they may be heated with producer gas or blast furnace gas, releasing all of the coke oven gas for use in the mills.

The ovens to be built at Clairton are of a design recently perfected by the Koppers Company and represent a great improvement over any previous development in the by-produce coke industry, either in this country or abroad. Improved quality of coke produced, making possible more economical blast furnace practice by reducing the consumption of coke per ton of iron produced, a faster coking time giving a greater capacity per oven per day, and stronger construction are the principal advantages of this new design.

This addition will increase the carbonizing capacity of the Clairton by-product coke plant by 8,500 tons of coal per day, and when completed, will bring the carbonizing capacity of this plant up to a total of 21,500 tons of coal per day. The present by-product coke plant at Clairton, already the largest of its kind in the world, furnishes coke and gas necessary to operate the blast furnaces and steel mills of the Carnegie Steel Company in the Pittsburgh district. The original installation, consisting of 10 batteries of 64 ovens each, was completed in 1917 and during 1918 two additional batteries of 64 ovens each were installed. This last addition of 366 ovens brings the total up to 1,134, all of which will have been designed and built by the Koppers Company.

Joseph Becker, of Pittsburgh, consulting engineer of the Koppers Company, is the inventor of this new oven. An experimental battery of ovens of this design has been in operation at the Koppers Company's plant in Chicago for the past year, and it is believed that the performance of this experimental plant was largely instrumental in deciding the Carnegie Steel Company to build this new type of oven.

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Review of a German Book on Open Hearths

Hubert Hermanns' Book, Entitled "Das Moderne Siemens-Martinstahlwerk," Interestingly Reviewed—Recently Published in Germany.

Review by WALTER de FRIES

THE purpose of this book, as Mr. Hermanns points out in the preface, is a description of open hearth plant equipment, with which he aims to fill in a space left in the literature pertaining to open hearth practice. There are a number of authentic books on the theory and practice of the open hearth process, while all knowledge of the necessary equipment beyond the furnace construction proper usually has to be gathered from trade publications, catalogues and magazine articles. In this respect the book is similar in many ways to the volume published two years ago by the Wellmann, Seaver, Morgan Company, entitled the "Open Hearth," with that distinction, however, that it is a survey of equipment as designed by the several German firms specializing in this line rather than a catalogue illustrating equipment of one particular company only, as in the case of the American book referred to. It is, therefore, of decidedly higher value, giving the seeker for knowledge at least a very good start and introduction, accompanied by an explaining text evidently intended for student consumption principally. There are a number of references and reprints from articles describing American plants, with some rather startling statements, such as, for instance, that the plant of the Weirton Steel Company is equipped with stationary 200-ton furnaces, but in general, one may say that Mr. Hermanns has evidently carefully studied the blast furnace and steel plant during the last few years and incorporated everything that may be of interest to his German readers in his book.

From the American viewpoint his book is interesting as evidently describing modern German practice. There is little, however, which could be copied—as is—though there are a few constructions which are conspicuous by their absence in American plants. Chief among these are electrically operated scrap-bundling machines, two types of which are illustrated; an electrically operated door-hoisting mechanism with one single motor drive for a series of doors, and the so-called "Heinzelmann Entlader" ("Unloader") for unloading coal, etc., from flat cars. The revolving turret type charging machine, evidently in general use abroad, may yet find some friends in this country, considering that it eliminates entirely the movement of the charge by rail and locomotive.

Interesting is the further description of open hearth port construction abroad, though it can hardly be recommended to follow the "rules of thumb" given by the writer for their design. The Gary works of the Steel Corporation will undoubtedly be interested to learn that their output of three heats per day in their 70-ton furnaces, with a total day production of 210 tons, is readily equalled by standard German 40-ton furnaces in hot metal practice. The superiority of the German furnace the writer attributes to the difference in height of the bath, which is, as he states, as high as 24 in. in the States, with a maximum of 12 in., now rarely exceeded in Germany, particularly. This is an interesting criticism, and the logic of the German pan design, as compared with our own, seems to merit investigation at least.

Of further interest is a description of a one-way flame type open hearth designed by Corsalli, stationary in structure and similar in principle to the 400-ton tilting furnace designed by Talbot, which was described in this journal not so long ago.

The chapter dealing with producers is an elaboration of an article by the same author, which appeared in the Blast Furnace and Steel Plant last year.

One misses a chapter on refractory materials for the open hearth, which would, if added, make the book more complete. On the other hand, there is an agreeable surprise at the end in the form of a 13-page bibliograph and reference guide, which alone is worth any price charged for the book, so much the more as it seems to be a rather complete survey of any and all articles, which have appeared in the last 10 or 15 years in the various leading steel industry periodicals in all parts of the world. A table at the end of the book, giving the evolution from the iron ore to finished products, has already been criticised in issue 27 (page 1078) of Stahl und Eisen, to which we refer.

There is need for a book of this character, not only in Germany but here also, and the more international the description of the various appliances is the more valuable is the book, undoubtedly. Mr. Hermann's book is typical German, and consequently of little value to the average American reader, except to the student of certain machinery and mechanism. If one would attempt again to write a book of this nature it is essential, not merely desirable, that the writer has more than a perfunctory knowledge of practice outside of Germany if he intends to be taken seriously. Impressions gained from reading of American magazine articles and unsupported by any personal contact with our leading industry, can hardly fail to be misconclusions in many cases, from which a book for students and designers should be free.

BUREAU OF MINES CHANGES

A. W. Ambrose, chief petroleum technologist of the United States Bureau of Mines, has been appointed assistant director of the bureau, to fill the vacancy created by the resignation of A. E. Holbrook, who has accepted the position of dean of the mining school at Pennsylvania State College. The appointment is effective October 1. The duties of F. J. Bailey, assistant to the director, have been increased by assigning to him virtually all of the business matters of the bureau formerly handled by the assistant director.

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NEWS OF THE PLANTS

George W. Armstrong, head of the George W. Armstrong Company, Fort Worth, Tex., manufacturer of iron products, and associates have organized the Armstrong Steel Company with a capital of $2,500,000 and 25,000 shares of common stock, no par value. The new company will succeed to the present Armstrong business and plans are being arranged for the remodeling of the plant into a modern steel mill. The production of bar iron and other commercial iron products will eventually be entirely discontinued and the bulk of operations concentrated on steel ingots and a line of steel products used extensively in this district. New mills will be constructed, estimated to cost close to $1,000,000, including machinery and operating equipment. To provide funds for this expansion the company is arranging for the immediate sale of a preferred stock issue aggregating $2,500,000. George W. Armstrong will be chairman of the board of the new company; R. L. Van Zandt will be president, and David R. Knapp, consulting engineer and formerly connected with the Eastern Steel Company, Philadelphia, will be vice president, in charge of operations.

The Wallingford Steel Company, Wallingford, Conn., recently organized with a capital of $200,000, is completing the installation of the initial machinery at its new local plant, and plans to inaugurate production at an early date. The new plant will specialize in the production of cold rolled steel products.

The Nekoosa Iron Works, Nekoosa, Wis., has plans under way for the construction of a new addition to its plant for increased production, comprising a one-story structure about 50x80 feet, and adjoining building 50x75 feet, estimated to cost close to $50,000, with equipment. Work will be commenced at an early date.

The Columbia Steel Corporation, 503 Market Street, San Francisco, Cal., comprising a recent merger of the Columbia Steel Company, San Francisco, and the Utah Coal and Coke Company, Salt Lake City, Utah, operating in Carbon and Iron Counties, Utah, has preliminary plans in progress for the construction of a number of additions to its plant at Pittsburg, Cal. The expansion will include a new rod mill, wire mill, nail works, and other structures, estimated to cost more than $1,500,000, including machinery and installation. It is proposed to commence work early in October and rush the structures through to completion. The new company is capitalized at $15,000,000.

The Greenville Steel and Iron Company, Greenville, Pa., care of the Greenville Chamber of Commerce, recently organized, has acquired a tract of property totaling about 35 acres of land for the construction of a new steel plant, to be devoted primarily to the production of alloy steels. The initial works, as projected, will include a 500-ton blast furnace, four 60-ton open hearth furnaces and one 10-ton open hearth furnace. The latter unit will be used almost entirely for experimental work. Other plan departments will include four rolling mills, cold drawing mill, electric power plant with capacity of about 15,000 horsepower, and other miscellaenous buildings. It is expected to develop an initial annual output of about 180,000 tons of pig iron and close to 165,000 tons of steel. Of the pig iron production it is estimated that the plant will use, itself, about 110,000 tons. Wherever possible the machinery installed will be electrically operated. The new plant is estimated to cost in excess of $1,500,000. The company is capitalized at $2,500,000 and is headed by Colonel H. P. Boke, formerly vice president of the Carnegie Steel Company, Pittsburgh, Pa.; H. E. McConnell, metallurgical engineer, also previously connected with the Carnegie Company; A. H. Davies will be general plant superintendent.

The Bethlehem Steel Corporation, Bethlehem, Pa., has tentative plans in progress for the construction of a number of additions to its plant at Sparrows Point, near Baltimore, Md. The work will include a new open hearth mill, plate mill, sheet and tinplate mills and miscellaneous structures, in full, to provide for an increased capacity of close to 300,000 tons per annum.

The Mesabi Iron Company, 25 Broad street, New York, N. Y., operating iron ore properties in the Mesabi Range, Minn., has arranged for a stock issue of $600,000, a portion of the proceeds to be used for extensions and improvements. The company is devoting a large portion of its output to the manufacture of iron ore concentrate, sinter. The present mill has a capacity averaging from 400 to 500 tons of sinter per day, with course crushing plant, power plant and other mechanical buildings used for operation. D. C. Jackling is president and W. G. Swart, vice president and general manager.

The International Harvester Company, Chicago, Ill., will commence the immediate construction of a new one-story open hearth furnace at its Wisconsin Steel Works, One Hundred and Sixth Street and Torrence Avenue. The plant unit will be 143x504 feet, and is estimated to cost approximately $300,000. The general contract has been awarded to the Bates & Rogers Construction Company, 37 West Van Buren Street, Chicago.

The Otis Steel Company, Cleveland, Ohio, has arranged for an increase in capital from 500,000 to 1,000,000 shares of stock. The excess being used in connection with a new bond issue to provide for plant extensions for considerably increased output. Plans are underway for a new steel plant to consist of open hearth furnaces, rolling mills and subsidiary structures, estimated to cost close to $1,000,000, including machinery. The new works will be used primarily to supply the sheet bar and slab requirements for the general plate and sheet mills of the company. It is expected to call for bids at an early date.

The Coast Range Steel Company, Victoria, B. C., organized a number of months ago with a capital of $15,000,000, is arranging with the provincial government for the construction of a new steel plant. It is proposed to issue bonds for about $4,000,000, to provide for the initial construction, while the ultimate plant will cost close to $10,000,000. It will consist of a blast furnace, open hearth plant and other subsidiary structures, equipped for an annual capacity of about 120,000 tons of steel. H. J. Landahl is one of the heads of the corporation.

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WITH THE EQUIPMENT MANUFACTURERS

NEW PORTABLE MEASURING INSTRUMENT MANUFACTURED BY WESTINGHOUSE CO

Portable ammeters and voltmeters of a new type, of which compactness, ruggedness, simplicity of construction and accuracy are important features, have been added to the line of instruments made by the Westinghouse Electric and Manufacturing Company.

The instruments, known as type PX-3 portable instruments, are direct reading meters for general testing purposes. The field of their applicaion is wide, including central station analysis tests; trade school, high school, and college equipment tests, and battery apparatus tests. They are particularly well suited for automobile and battery testing. A set of six of these instruments is not as bulky to carry as one ordinary large portable instrument.

The movements of these instruments, which operate on the D'Arsonval principle, are light in weight, assuring a minimum of pivot and jewel wear and preventing injurious effects from shocks or vibration. Since the complete movement is mounted on a micarta sub-base which can be removed as a unit, it can be completely adjusted outside of the case where all parts are accessible.

The cases are made of moulded composition. This material is not only strong, but acid resisting, which makes the instruments particularly useful for battery testing. Some other distinctive features of the instruments are that they have a degree of accuracy not previously found in instruments of such a small size; the relation of torque to weight is more favorable than in larger instruments; the round open-face construction gives good lighting on the scale; the dials are clear and legible with a mirror under the pointer to eliminate parallax; the calibration is as permanent as that of larger instruments, and all the instruments have external zero adjusters.

NEW SQUIRREL-CAGE INDUCTION MOTOR

The Electric Controller and Manufacturing Company of Cleveland, Ohio, are putting on the market a squirrel-cage induction motor. They make some very broad claims regarding this motor and have introduced new ideas in motor design. It is claimed that this motor is better not only from a mechanical standpoint, but from the standpoint of efficiency, power-factor and torque.

No filing or fitting is allowable in the manufacture of the motor, but it is so carefully built mechanically that the various parts must fit or be rejected. The stator frame is cast around the stator limitations, thus insuring perfect rigidity and alignment. The shrinkage of the frame after pouring puts the laminations under heavy pressure and removes any possibility of the motor becoming nosy. The frame is of the skeleton type, so that the major portion of the stator laminations are exposed to the air. Fan blades are used on only a few of the 900-rpm. motors. The 1,2000 and 1,800-rpm. motors do not have fan blades, as most of the cooling is done by direct contact of the laminations with the air.

The stator windings are all impregnated twice: once after the coils are wound and again after the stator is completely assembled and wired. All coils are form-wound, and open-slot construction is used. The same care is used in the manufacture of all of these stators that is ordinarily used only when severe moisture or oil paper conditions are to be met.

The bearings are extra large and each bearing is provided with two oil rings, one of which is sufficient to properly lubricate the bearing. The extra ring is used as a factor of safety.

The oil wells are larger than is ordinarily used, so as to give further protection against hot bearings. The rotor has cast end rings and the shaft is made much larger than standard engineering practice demands.

COMBINATION CLUTCH AND BRAKE FOR TUMBLING MILLS

The "safety first" movement has resulted in many improvements in foundry and shop equipment. One of the latest is a combination clutch and brake mechanism for tumbling mills.

This is a simple and really fool-proof device, controlled by a hand lever. Shifting this lever towards the mill engages the clutch and starts the mill To stop the mill, the lever is moved in reverse direction, passing through neutral to the braking position.

The advantages of such a mechanism are easily seen. A loaded mill can be brought to rest at exactly the right point for unloading and without loss of time. Holding the mill in place by a wood prop or a bolt thrust into the gearing, as is commonly done, is always dangerous. With the combination clutch and brake it is impossible for the barrel to turn after the brake is set, even though the barrel is unequally loaded.

This mechanism was devised by Whiting Corporation, Harvey, Ill., and wa sthoroughly tested in their own foundry before being placed on the market. U S. Leters Patent were issued June 6, 1922.

PORTABLE WELDING SET IS SEMIAUTOMATIC

To increase the applicability of its semiautomatic arc welding apparatus and to make it available for use in any part of the factory or shop, the General Electric Company, Schenectady, N. Y., has placed on the market a portable set. This unit comprises a complete equipment, with support for a wire reel, mounted on a small truck that can be pulled over the shop floor or lifted by a crane. The equipment weighs about 400 pounds.

Briefly, the outfit consists of a semiautomatic lead, an automatic welding head with control, and a standard for holding a reel of electrode wide. Power is supplied to the arc through a flexible cable with a plug for attaching it to the nearest welding circuit. The reel carrier is equipped with a brake and designed to take any size up to 2½ feet in diameter.

It is believed that this portable set will be used to advantage in repairing parts of machines in place when these parts are too bulky, inconvenient, or otherwise impractical to move. It is useful also for doing routing welding of all kinds, such as fillin gholes in castings, welding seams in pipes of tanks and similar work.

KEY-TITE SELF-FITTING KEYS

Smith & Serrell, Newark, N. J., have perfected the details of Keytite Self-Fitting Keys which give an easier and better way to obtain a fit between keys and keyways than by the old method of hand fitting.

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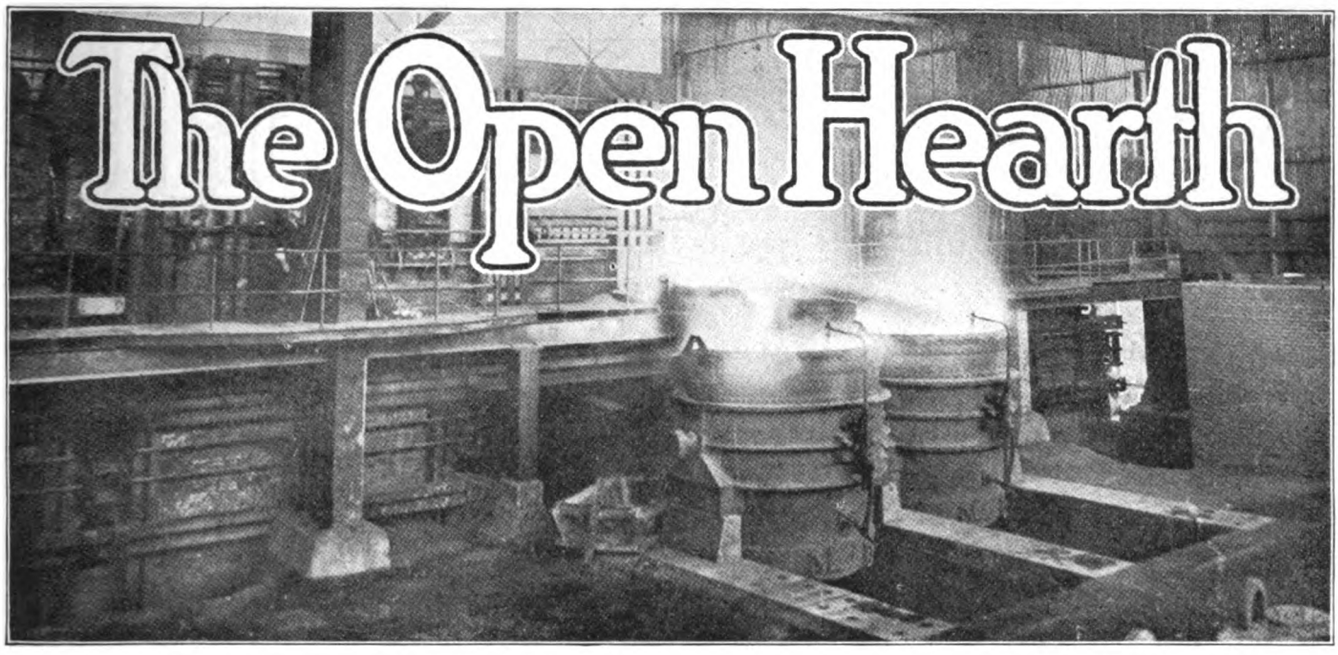

Charles E. Hulick, superintendent of blast furnaces of the Thomas Iron Company, Hokendauqua, Pa., has resigned, effective September 1.

V V

Joseph Edmunds was recently appointed superintendent of finishing mills, No. 2 plant, Inland Steel Company, Indiana Harbor, Ind. Mr. Edmunds was formerly superintendent of structural mill, Illinois Steel Company, South Chicago, Ill.

V V

E. L. Ford is president of the Youngstown Steel Company, Youngstown, Ohio, which is installing a mechanical puddling plant at Warren, Ohio. Mr. Ford is a son-in-law of Joseph G. Butler, Jr., Youngstown, and has been associated with the development of the iron and steel industry of the Mahoning Valley for many years. Mr. Ford is a director of the Youngstown Sheet and Tube Company and a member of the executive committee of the Brier Hill Steel Company. The mechanical puddling machine to be used in the Warren installation is the result of years of experimentation by Mr. Ford and associates. It is modeled after a design by Mr. Ford, fully covered by patents. Plans provide for an extensive plant, to consist of two blast furnaces, by-product coke oven complement and 16 mechanical puddling machnes.

V V

Charles O. Rowe has become associated with Carson & Company, Pennsylvania Building, Philadelphia, and will have charge of the company's steel department.

V V

Charles C. Hill was general superintendent of the Schoenberger works of the American Steel and Wire Company, Pittsburgh, up until two weeks ago, when he was transferred to the Newberg steel works of this company, Cleveland, as general superintendent, succeeding Bertram D. Quarrie, now general manager of the Otis Steel Company, Cleveland. Mr. Hill has been associated with the American Steel and Wire Company since 1892 in the capacity of timekeeper, chief clerk, superintendent Bessemer department and assistant general superintendent. He was appointed general superintendent of the Schoenberger works last October. Mr. Hill's successor will be appointed soon.

V V

William J. Fountain resigned his position with the blast furnace department of the Illinois Steel Company at Joliet to become associated with the Cleveland-Cliffs Iron Company, at Marquette, Mich., in the capacity of blast furnace superintendent.

V V

George T. Christopher has been made general superintendent of the Dayton Engineering Laboratories Company, Dayton, Ohio. He was formerly assistant superintendent and production manager.

V V

Samuel Hench has been made superintendent for the Sterling Steel Foundry Company, Braddock, Pa., of which, for the past five years, he has been foreman.

V V

George M. Thompson resigned as vice president of the Wickwire Spencer Steel Corporation and will retire from active business for a time. However, he will continue as a member of the board of directors. Mr. Thompson has been connected with the wire industry for more than 27 years in the Worcester, Mass., district.

V V

J. J. Becker has been made superintendent of the blast furnace plant of the Temple Furnace Company, Temple, Pa. This company was incorporated recently to take control of the plant formerly operated by the Seaboard Steel and Manganese Company. Repairs have been made and the plant will start operation in the near future.

V V

E. W. Rossiter has been appointed engineer of construction for Freyn, Brassert & Company. He was previously chief engineer of the Interstate Iron and Steel Company, Calumet River, Chicago, and prior to that was with the American Sheet and Tin Plate Company, the Minnesota Steel Company and the Canadian Steel Corporation, Ltd., Ojibway, Ont.

V V

Harold L. Stevens, who has been appointed general sales manager of Central Iron and Steel Company, Harrisburg, Pa., has spent practically his entire life in the steel business. He was employed in the Sweet mills at Syracuse, N. Y., and later by the Sweet's Steel Company, Williamsport, Pa. Some years later he joined the Lackawanna Steel Company, in the Buffalo sales department. He was made New England district sales manager of the Lackawanna Steel Company about 11 years ago, with headquarters in Boston. A native of Portland, Me., he attended Cornell Universty and is an ex-president of the

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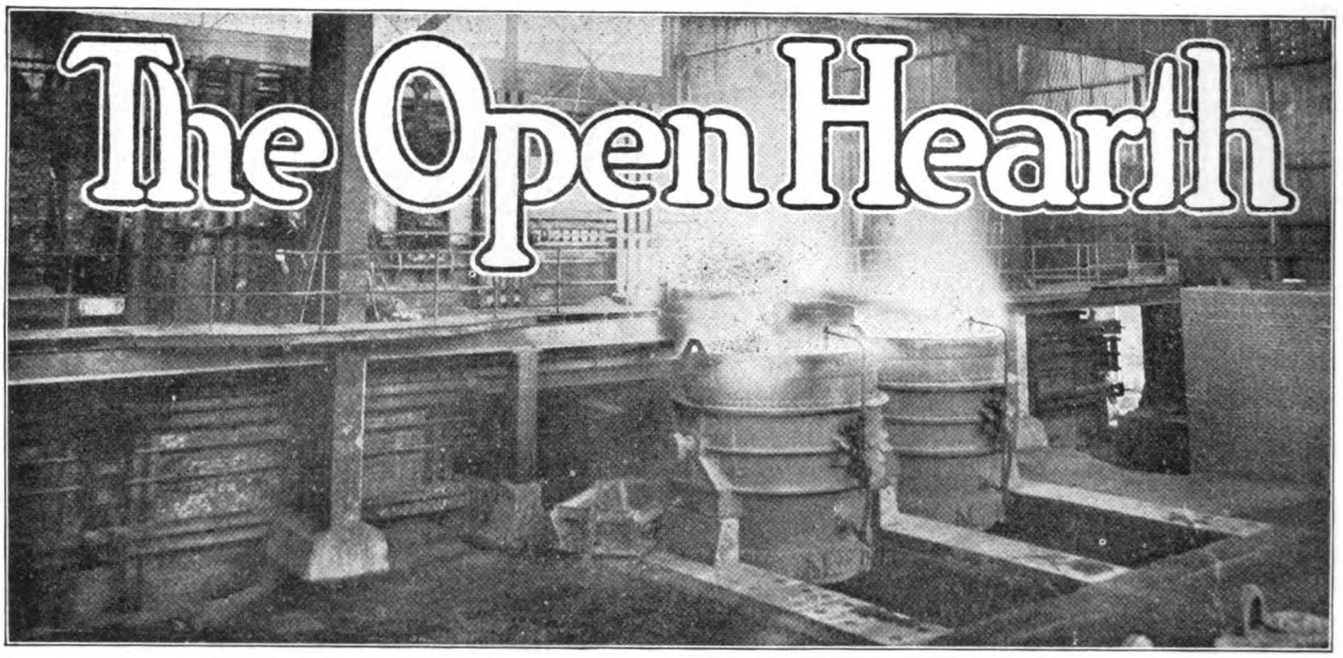

Cornell Club of New England. The change takes effect September 1.

V V

C. N. Phillips, for the past five years superintendent of the Reading Steel Casting Company, Reading, Pa., has taken charge of the steel foundry department of the Chapman Valve Manufacturing Company, Indian Orchard, Mass. Mr. Phillips was connected with the Reading Steel Casting Company for a period of 22 years, starting as a workman and advancing by stages to the position of superintendent. He was also identified with a valve manufacturing business in Reading.

V V

Arthur Whitcraft, manager manganese steel sales, Hadfield. Penfield Steel Company, Bucyrus, Ohio, in addition to his previous duties, has also been placed in charge of all foundry operations at the South Works at Bucyrus, Ohio.

V V

J. A. McCrory, formerly secretary and general manager of sales of the American Steel Company, Pittsburgh, and C. T. Baird, who was president of Charles T. Baird & Company have formed a partnership under the firm name Baird & McCrory, Inc., with offices at 140 Nassau street, New York.

V V

F. D. Gordon was recently appointed manager of the Gary Screw and Bolt Company Works, Gary, Ind., succeeding C. E. Carr, who had been manager for a number of years.

V V

A. L. Roberts has been appointed sales engineer, railroad department of the United Alloy Steel Corporation, Canton, Ohio. Mr. Roberts was formerly master mechanic of the Lehigh Valley Railroad and recently chief engineer of the Atlas Crucible Steel Company.

V V

Bertram H. Lawrence, district engineer, American Steel and Wire Company, Worcester, Mass., has been made chief engineer to succeed W. E. Snyder, Pittsburgh, who recently died. Matthew R. Fish, chief draughtsman, South Works, Worcester, succeeds Mr. Lawrence as district engineer. Mr. Lawrence will have charge of power and mechanical equipment, with headquarters at Pittsburgh, and will take up his duties this month. He originally was with the Chicago office of the company and went to Worcester about seven years ago. His education as a mechanical engineer was received at the University of North Carolina.

Joseph H. Swift, master mechanic, South Works, American Steel and Wire Company, Worcester, Mass., has been made chief draughtsman to succeed Matthew R. Fish, who is now district engineer. Joseph Ashworth, shop foreman at the North Works, succeeds Mr. Swift as master mechanic at the South Works.

V V

S. P. Ker, Jr., Sharon, Pa., has been appointed general manager of sales of the Ashtabula Steel Company, Ashtabula, Ohio. The company is completing an eight-mill sheet plant. Mr. Ker is a son of Severn P. Ker, president of the Sharon Steel Hoop Company.

V V

Mr. Charles Gray Cooper, for 45 years identified with the C. & G. Cooper Company, engine builders, Mt. Vernon, Ohio, died at his home in Mt. Vernon at 5 A. M., August 4, 1922, after an illness dating from April, 1918. He was born in Mt. Vernon December 11, 1845, and was the son of Elias Cooper, who, with his brother, Charles Cooper, founded the C. & G. Cooper Company, 90 years ago. He was educated in the public schools of Mt. Vernon and at Oberlin College. Mr. Cooper was one of the pioneer engine builders of this country and practically his entire life was spent in the development and building of Cooper steam and gas engines.

V V

Mr. D. W. Elliot, general superintendent of the Joseph E. Thropp furnaces, died at his residence at Earlston, Pa., July 24, from apoplexy. Mr. Elliot was formerly connected with the Schoenberger furnaces and steel plant, the Central furnaces in Cleveland, the Donora furnaces, the Cambria Steel Company and the Joseph E. Thropp furnaces.

V V

Thomas H. Wickenden and Charles McKnight, Jr., have recently joined the development and research department of the Inernational Nickel Company, New York, to undertake development work in connection with alloy steels. Mr. Wickenden was for many years associated with the Studebaker Corporation as engineer-in-charge at the South Bend plant and more recently associated with Zeder-Skelton-Breer Engineering Company in a consulting capacity. Mr. McKnight was formerly works manager of the Carbon Steel Company and engaged for many years in the production of alloy steels.

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Some Pointers on By-Product Coke Oven Operations

WEIRTON STEEL COMPANY TO BUILD BY-PRODUCT PLANT

The Weirton Steel Company, Weirton, W. Va., has awarded the Koppers Company a contract to build a by-product coke plant and motor fuel recovery plant. Work already has begun on the first battery of the by-product plant which will consist of 37 ovens of the Koppers Company's new design, with a capacity of producing more than 600 net tons of coke per day, entirely from high volatile coal. It is expected that this unit will be completed and in operation late in the summer of 1923. Ultimately the plant will consist of three batteries of ovens.

The design of the ovens to be built at Weirton is the same as that of the 5-oven battery which has been in operation at the plant of the Chicago By-Product Coke Company for the past six months. Each oven will have a capacity of more than 14 net tons of coal per charge. This new type of oven is about 14 in. wide and embraces an entirely different system of heating than the old Koppers design. The ovens are so arranged that at any time they can be heated with either blast furnace or producer gas, thus releasing all the valuable coke oven gas for use in the steel works. The Chicago plant, with ovens like those to be constructed at Weirton, has been operating on an average coking time of 12 hours and has been on as low coking time as 9 hours 50 minutes.

LIGNITE TAR DISTILLATION

Lignite tars are profitably distilled at reduced pressure, in order to save time and fuel, and to reduce the tendency of the tar to crack. In Germany, it was formerly customary to start the distillation with a pressure of 10 cm. (4 in.) of mercury below atmospheric, and to finish the process at a pressure deficiency of 40 cm. (16 in.). When, during the war, the demand for fuel oils and producer tar from lignite increased, attempts were made to work with higher vacua, while at the same time the capacity of the still was enlarged. Of the various processes introduced, only those of the Deutsche Erdol A.G., of Rositz, seem to have survived, the plants being supplied by the Brunn-Konigsfeld engineering works, which specialize in this field. In one of these plants, described by Dr. E. Graefe, in *Brennstoff-Chemie*, of June 1, the pressure reduction is carried to 68 cm. (27 in.), and there are eight boilers or continuous stills, each of 40 cu. m (1,400 cu. ft.) capacity. The stills resemble horizontal Cornish boilers. They are arranged in series and slightly in cascade, so that the liquid flows from one still into the other. The vapors from each boiler pass into a dephlegmator, which is placed inside the preheaters of the respective boiler, so that distillation begins in the dephlegmator, which is coupled to its own condenser; 16 separate fractions of the distillate may be drawn from the stills and condensers. The still temperatures range from 200 deg. C. to 320 deg. C. The final distillation to coking takes place in special cast iron stills. One of the advantages claimed for the process is that good lubricating oils and paraffins are obtained.

INCREASING THE RATE OF CARBONIZATION

According to a paper read before the Institution of Gas Engineers, it would appear that an increase in the rate of carbonization, caused by alteration in the chemical and physical conditions, is accompanied by improvement in the calorific value of the gas, and of the thermal and volume yields per ton of coal. Improvement is found in every direction.

Very considerable increase in the rate of carbonization may be obtained by selection of those coals which give up their gas above a minimum rate. Except in the case of oxidized coals, the calorific value of the gas, and consequently the thermal yields, are higher for an increased rate.

When an increase in the rate of carbonization is caused by an increase in carbonizing temperature, the results are complicated by the fact that the portion of the gas evolved on the outside of the plastic layer is subjected to an increased degradation. This opposes the tendency of the higher rate to give gas of superior calorific value. Up to the end of a certain time, the calorific value of the higher temperature gas is smaller than that of the lower, but, volume for volume, there is a slight balance in favor of the high temperature gas. After a certain period, when the coal at high temperature is nearly carbonized, the calorific value falls off rapidly, while the coal at low temperature is still producing gas of moderate quality.

An increase in volume and thermal yields per ton follows an increase in rate, due to a higher carbonizing temperature, which it is impossible to obtain at lower temperature.

Volume for volume, the calorific value of the higher temperature gas falls off at a slightly greater rate than the lower temperature gas, but a greater volume of gas is evolved from the former, which quickly makes up for the deficiency.

METALLURGICAL COKE

The problem of utilizing the heaps of such low grade coal that in itself has no marketable value has occupied many minds for many years, but a distinct step forward appears now to have been made. The flotation process of dealing with low grade ores is common in the ore fields, for instance, of South Africa and Australia, and it is the application of this process to what ordinarily may be termed rubbish heaps at the coal pits in this country which has demonstrated the possibility of getting the full value out of these heaps. The most important development, perhaps, is that the Powell Duffryn Steam Coal Company has entered into an agreement with Minerals Separation, Ltd., the company owning the patents, for the treatment of their low grade material, both for briquetting and for the manufacture of metallurgical coke. By the grinding of this material to practically a powder, and its treatment in a simple washing process with a chemical reagent, it has been found possible easily to remove all the superfluous matter, leaving a residue of practically pure coal, and, of course, moisture. Subsequent processes enable this moisture to be reduced to 3 or 4 per cent, and we have a product consisting, to all intents and purposes, of pure coal. When converted into metallurgical coke it has been proved to be a much superior material to the ordinary metallurgical coke, and the company owning the patents is making considerable progress in all parts of the world. This opens up enormous prospects for colliery owners, and it may be that we have at last reached the stage at which the disposal of the large heaps of extremely low grade coal, of which so much has been heard from time to time, will be possible, with advantage to the colliery owners and also to the users of the resultant product.—*Mechanical World.*

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TRADE PUBLICATIONS

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has just completed the preparation of a 64-page illustrated publication on mining apparatus. In addition to line material, the publication, which is known as Catalogue 6-M, contains much information about mine safety switches, Frankel solderless connectors, tapes, babbits, solders, micarta gears, mine locomotives and mine locomotive headlights.

Pennsylvania Pump & Compressor Company, Easton, Pa., has issued a new 16-page bulletin, No. 202, describing the company's line of double suction single stage centrifugal pumps and containing useful engineering data.

G. P. Wincott, Ltd, Sheffield, England, have issued a most complete catalogue descriptive of the Wincott furnaces. This company are designers and builders of every type of metallurgical furnace, and have constructed furnace equipment for the leading steel plants in Great Britain and the Continent.

Charles J. Clark Blast Meter Company, Gladbrook, Iowa, have issued a booklet describing the engineering and operating details of the Clark blast volume meter, velocity meter and mercury blast pressure gauge. This meter is used to measure volume rather than pressure.

The F. J. Ryan & Company, Philadelphia, have issued several bulletins on electric furnace subjects, under the tiles of "Electric Heat and What It Is" and "The Electric Resistor." Either will be sent upon request.

The Ohio Electric and Controller Company have issued a pamphlet descriptive of the ball bearing motor which they have introduced to the trade. This new line of small motors has been designed to meet the demand for high grade motors for application to domestic appliances, pumps, machines and other devices whch are operated from lighting circuits.

"A Neglected Source of Economy" is the title of a new publication issued by the Armstrong Cork and Insulator Company, Pittsburgh, Pa. It deals with the savings that can be effected in manufacturing plants by the use of refrigerated drinking water systems.

Unique and attractive best describes the new folder just issued by the Van Dorn & Dutton Company, gear manufacturers, Cleveland, Ohio. It is entitled "Bringing the Van Dorn Plant Home to You." It is a complete description of the Van Dorn plant.

Bulletin A, giving a condensed description of the Quigley powdered coal system and appliances has just been issued by the Quigley Fuel Systems, Inc., New York City. The layout of a typical coal milling plant is shown and the methods of fuel distribution and control briefly described.

W. A. Jones Foundry & Machine Company, Chicago, Ill., announce the new catalogue No. 24, on Jones gears. This catalogue lists a most complete line of cast-tooth gear patterns. In additon it contains list prices for Rawhide pinions as well as miscellaneous information useful when laying out gear drives or for estimating purposes.

TRADE NOTES

F. J. Ryan & Company, industrial heating equipment manufacturers, Wesley Building, Phladelphia, announce the closing of contracts for equipments to be installed for the following concerns: Bethlehem Steel Corporation, American Fork & Hoe Company, J. G. Brill Company, American Steel & Wire Company, Webb Wire Works.

Monroe L. Patzig, 206 Eleventh Street, Des Moines, Iowa, has been appointed representative of the Conveyors Corporation of America, 326 West Madison Street, Chicago, for the sale of their American trolley carrier. Mr. Patzig's territory lies in Central Iowa.

Scheid Engineering Corporation, 90 West Street, New York City, has been appointed metropolitan and export representative for the Franklin Moore Company, Winsted, Conn., manufacturers of material handling machinery for industrial plants.

The Cambria Steel Company have placed with Arthur G. McKee & Company, Cleveland, a contract for the design and furnishing of materials for their No. 4 furnace top at Johnstown, Pa. The new layout will include a McKee revolving distributor and auxiliary furnace top equipment.

The Syracuse Lighting Company, Syracuse, N. Y., proposes to install three 5000-kva. transformers at its Solvay Station and one 5000-kw. frequency changer at its Fulton Street Station. The contract for both these installations has been awarded the U. G. I. Contracting Company.

The Conveyors Corporation of America, 326 West Madison Street, Chicago, has appointed the Mid-West Engineering Sales Company, Masonic Temple, Cedar Rapids, Iowa, representatives in Eastern Iowa for the sale of American trolley carriers, which is coal handling equipment of the monorail type.

Des Moines, Ind., Gas Company will shortly erect a 2,500,000 cu. ft. capacity storage holder. The contract for installing the foundations and supervising the erection of the holder has been awarded to the U. G. I. Contracting Company of Philadelphia.

Arthur G. McKee & Company, Cleveland, have been awarded a contract by the Rochester & Pittsburgh Coal & Iron Company for designing and installing a new trestle and storage bins at the plant of the Adrian Furnace Company, DuBois, Pa. The improvements to be made include a steel and reinforced concrete trestle structure approximately 480 ft. long, six ore bins, coke bin and coke breeze handling equipment. The coke bin will be centrally located, discharging direct over cascade type screens into the skip cars, and will provide storage for approximately 135 tons of coke. Two 80-cu. ft. capacity scale cars will be furnished for handling materials from the ore and limestone bins.

A new electro-graphitic brush, known as "259," has been placed on the market by the National Carbon Company, Inc. Exhaustive tests on a large variety of d.c. motors and generators, and on the d.c. side of rotary converters, have demonstrated that it is adapted to a very wide range of voltages, current densities and speeds on undercut commutators.

Changes affecting the personnel of the Atlanta, Denver, Seattle, New York, San Francisco and New Orleans offices have been announced by officials of the Westinghouse Electric & Manufacturing Company. In the Atlanta office, R. H. Moore has been appointed office manager and Thomas Fuller has been made manager of the Central Station division and has been placed in charge of the sale of supply apparatus. E. C. Means has been appointed manager of the Central Station and Transportation divisions of the Denver office and J. P. Sprunt, Jr., has been made manager of the Merchandising division, which was recently organized there. Mr. Sprunt will also have general charge of the sale of supply apparatus in the Denver territory. J. G. Miles has been appointed manager of the Central Station division and has been placed in general charge of the sale of supply apparatus in the Seattle district. A. W. Eshelby has been appointed manager of the Transportation division and A. A. Miller has been made special representative in large negotiations and power developments in the Seattle office. C. V. Holmes has been appointed district auditor with headquarters in the New York sales office. Edward C. McCarty has been appointed treasury and accounting representative of the San Francisco office, succeeding A. L. Austin, resigned. O. P. McCord has been appointed branch manager of the New Orleans office.

Contracts for the construction of furnaces for the new seamless tube plant of the Weldless Tube Co., Wooster, O., have been placed with Buell, Scheib & Mueller, Inc., Columbia Bank building, Pittsburgh.

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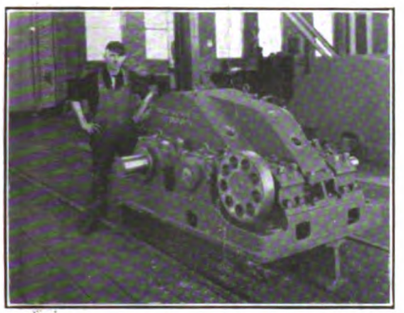
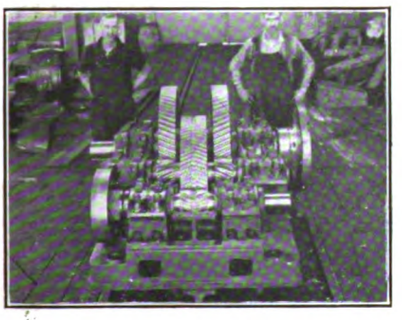
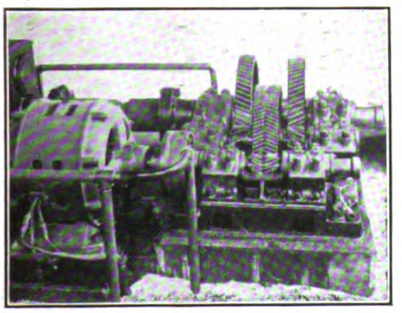
The Blast Furnace and Steel Plant

Pittsburgh, September, 1922.







Continuous Production and Operation is Recognized as Vital to the Attainment of Lowest Costs.

And continuity of power transmission is equally as vital. There must be no leaks in the energy stream as it is distributed through the mill.

Fawcus Herringbone Gear Drives and the use of individual motors have simplified power transmission among mills everywhere, giving greater Power, Reduction, Speed, Silence, Efficiency, and Durability.

Let us get together on your drive problems.

This installation was made three years ago in the plant of The Columbia Steel Co., Elyria, Ohio, of 100 H.P. 690 to 26 R.P.M. Fawcus Herringbone Gear Drive connected to 14" Cold Strip Mill has resulted in a decrease in power consumption of 15%, increase in production of 20%, better quality product than when spur gears were used, due to the continuous contact and smooth running of Fawcus Herringbone Gears. Elimination of vibration and noise. Note position of motor in this picture which saves considerable floor space.

Rolling Mills and Equipment, Special Machinery, Spurs, Bevels, Worms, Worm Wheels, Flexible Couplings, Worm Reduction Drives.

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NEW YORK, N. Y., Robt. C. Brown, 84 Pine St.
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PORTLAND, ORE., Coast Steel Machinery Co.
SAN FRANCISCO, CALIF., K. W. Eichelberger.

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